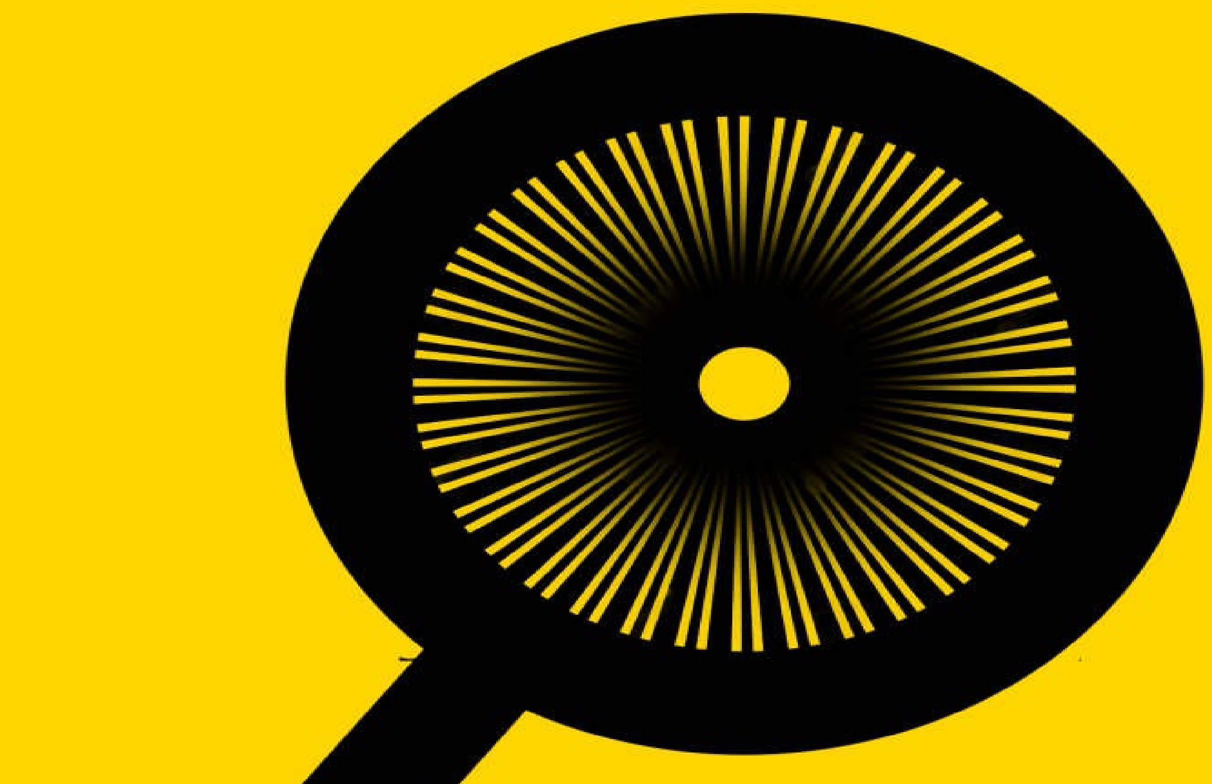
Cognitive Science



Focus On

by Wikipedia contributors

Focus On: Cognitive Science

Linguistics, Cognition, Perception, Theory of Mind, Metacognition, Schema (psychology), Learning Curve, Computational Linguistics, Functionalism (philosophy of mind), Generative adversarial Network, etc.

by Wikipedia contributors

For a detailed list of authors, please use the link to the authors provided at the end of each article.

This edition has been last updated 2018-06-14

Contact: focuson@okpublishing.info

EAN 4057664172112

Editorial note:
this carefully crafted ebook is formatted for your eReader with a functional and detailed table of contents. The Focus On books are made out of collections of Wikipedia articles regrouping the most informative and most popular* articles about a specific subject. The Focus On books are regularly updated and they are a result of a substantial editorial work of selecting and grouping relevant articles together in order to create a valuable source of information about specific subjects. Focus On (an imprint of OK Publishing) charges for the convenience service of formatting these e-books. We donate a part of our net income after taxes to the Wikimedia Foundation from the sales of all e-books based on Wikipedia content. You can access the original Wikipedia articles on the internet free of charge. This book does not contain tables, illustrations or illustration descriptions.

*According to Wikipedia page views in the last 90 days when this edition was last updated

Main table of contents:

*Articles sorted according to the popularity of the Wikipedia article in the last 90 days, as measured on the date of publication of this updated edition.

Search articles:

A, B, C, D, E, F, G, I, L, M, N, P, Q, R, S, T, U, V

View in alphabetical order

View in order of popularity*

Back to main TOC

Contents

Linguistics

Jump to navigation Jump to search
This article is about the field of study. For the journal, see Linguistics (journal).
"Linguist" redirects here. For other uses, see Linguist (disambiguation).

Linguistics is the scientific study of language,[1] and involves an analysis of language form, language meaning, and language in context.[2] The earliest activities in the documentation and description of language have been attributed to the 6th century BC Indian grammarian Pāṇini,[3][4] who wrote a formal description of the Sanskrit language in his *Aṣṭādhyāyī*.[5]

Linguists traditionally analyse human language by observing an interplay between sound and meaning.[6] Phonetics is the study of speech and non-speech sounds, and delves into their acoustic and articulatory properties. The study of language meaning, on the other hand, deals with how languages encode relations between entities, properties, and other aspects of the world to convey, process, and assign meaning, as well as manage and resolve ambiguity.[7] While the study of semantics typically concerns itself with truth conditions, pragmatics deals with how situational context influences the production of meaning.[8]

Grammar is a system of rules which governs the production and use of utterances in a given language. These rules apply to sound[9] as well as meaning, and include componential subsets of rules, such as those pertaining to phonology (the organisation of phonetic sound systems), morphology (the formation and composition of words), and syntax (the formation and composition of phrases and sentences).[10] Modern theories that deal with the principles of grammar are largely based within Noam Chomsky's framework of generative linguistics.[11]

In the early 20th century, Ferdinand de Saussure distinguished between

the notions of *langue and parole* in his formulation of structural linguistics. According to him, *parole* is the specific utterance of speech, whereas langue refers to an abstract phenomenon that theoretically defines the principles and system of rules that govern a language.[12] This distinction resembles the one made by Noam Chomsky between competence and performance in his theory of transformative or generative grammar. According to Chomsky, competence is an individual's innate capacity and potential for language (like in Saussure's *langue*), while performance is the specific way in which it is used by individuals, groups, and communities (i.e., *parole*, in Saussurean terms).[13]

The study of *parole* (which manifests through cultural discourses and dialects) is the domain of sociolinguistics, the sub-discipline that comprises the study of a complex system of linguistic facets within a certain speech community (governed by its own set of grammatical rules and laws). Discourse analysis further examines the structure of texts and conversations emerging out of a speech community's usage of language.[14] This is done through the collection of linguistic data, or through the formal discipline of corpus linguistics, which takes naturally occurring texts and studies the variation of grammatical and other features based on such corpora (or corpus data).

Stylistics also involves the study of written, signed, or spoken discourse through varying speech communities, genres, and editorial or narrative formats in the mass media.[15] In the 1960s, Jacques Derrida, for instance, further distinguished between speech and writing, by proposing that written language be studied as a linguistic medium of communication in itself.[16] Palaeography is therefore the discipline that studies the evolution of written scripts (as signs and symbols) in language.[17] The formal study of language also led to the growth of fields like psycholinguistics, which explores the representation and function of language in the mind; neurolinguistics, which studies language processing in the brain; biolinguistics, which studies the biology and evolution of language; and language acquisition, which investigates how

children and adults acquire the knowledge of one or more languages.

Linguistics also deals with the social, cultural, historical and political factors that influence language, through which linguistic and language-based context is often determined.[18] Research on language through the sub-branches of historical and evolutionary linguistics also focus on how languages change and grow, particularly over an extended period of time.

Language documentation combines anthropological inquiry (into the history and culture of language) with linguistic inquiry, in order to describe languages and their grammars. Lexicography involves the documentation of words that form a vocabulary. Such a documentation of a linguistic vocabulary from a particular language is usually compiled in a dictionary. Computational linguistics is concerned with the statistical or rule-based modeling of natural language from a computational perspective. Specific knowledge of language is applied by speakers during the act of translation and interpretation, as well as in language education – the teaching of a second or foreign language. Policy makers work with governments to implement new plans in education and teaching which are based on linguistic research.

Related areas of study also includes the disciplines of semiotics (the study of direct and indirect language through signs and symbols), literary criticism (the historical and ideological analysis of literature, cinema, art, or published material), translation (the conversion and documentation of meaning in written/spoken text from one language or dialect onto another), and speech-language pathology (a corrective method to cure phonetic disabilities and dis-functions at the cognitive level).

TOP

TOC Next

Nomenclature

Before the 20th century, the term *philology*, first attested in 1716,[19] was commonly used to refer to the study of language, which was then predominantly historical in focus.[20][21] Since Ferdinand de Saussure's insistence on the importance of synchronic analysis, however, this focus has shifted[22] and the term *philology* is now generally used for the "study of a language's grammar, history, and literary tradition", especially in the United States[23] (where philology has never been very popularly considered as the "science of language").[19]

Although the term "linguist" in the sense of "a student of language" dates from 1641,[24] the term "linguistics" is first attested in 1847.[24] It is now the usual term in English for the scientific study of language,[*citation needed*] though *linguistic science* is sometimes used.

Linguistics is a multi-disciplinary field of research that combines tools from natural sciences, social sciences, and the humanities.[25][26][27] Some, such as David Crystal, conceptualize the field as being primarily scientific.[28] The term *linguist* applies to someone who studies language or is a researcher within the field, or to someone who uses the tools of the discipline to describe and analyse specific languages.[29]

Variation and universality

While some theories on linguistics focus on the different varieties that language produces, among different sections of society, others focus on the universal properties that are common to all human languages. The theory of variation therefore would elaborate on the different usages of popular languages like French and English across the globe, as well as its smaller dialects and regional permutations within their national boundaries. The theory of variation looks at the cultural stages that a particular language undergoes, and these include the following.

Pidgin

The pidgin stage in a language is a stage when communication occurs through a grammatically simplified means, developing between two or more groups that do not have a language in common. Typically, it is a mixture of languages at the stage when there occurs a mixing between a primary language with other language elements.

Creole

A creole stage in language occurs when there is a stable natural language developed from a mixture of different languages. It is a stage that occurs after a language undergoes its pidgin stage. At the creole stage, a language is a complete language, used in a community and acquired by children as their native language.

Dialect

A dialect is a variety of language that is characteristic of a particular group among the language speakers.[30] The group of people who are the

speakers of a dialect are usually bound to each other by social identity. This is what differentiates a dialect from a register or a discourse, where in the latter case, cultural identity does not always play a role. Dialects are speech varieties that have their own grammatical and phonological rules, linguistic features, and stylistic aspects, but have not been given an official status as a language. Dialects often move on to gain the status of a language due to political and social reasons. Differentiation amongst dialects (and subsequently, languages too) is based upon the use of grammatical rules, syntactic rules, and stylistic features, though not always on lexical use or vocabulary. The popular saying that "a language is a dialect with an army and navy" is attributed as a definition formulated by Max Weinreich.

Universal grammar takes into account general formal structures and features that are common to all dialects and languages, and the template of which pre-exists in the mind of an infant child. This idea is based on the theory of generative grammar and the formal school of linguistics, whose proponents include Noam Chomsky and those who follow his theory and work.

TOC Previous Next

Discourse

Discourse is language as social practice (Baynham, 1995) and is a multilayered concept. As a social practice, discourse embodies different ideologies through written and spoken texts. Discourse analysis can examine or expose these ideologies. Discourse influences genre, which is chosen in response to different situations and finally, at micro level, discourse influences language as text (spoken or written) at the phonological or lexico-grammatical level. Grammar and discourse is often like and together it is a sort of system.[32] A particular discourse becomes a language variety when it is used in this way for a particular purpose, and is referred to as a register.[33] There may be certain lexical additions (new words) that are brought into play because of the expertise of the community of people within a certain domain of specialization. Registers and discourses therefore differentiate themselves through the use of

vocabulary, and at times through the use of style too. People in the medical fraternity, for example, may use some medical terminology in their communication that is specialized to the field of medicine. This is often referred to as being part of the "medical discourse", and so on.

Standard language

When a dialect is documented sufficiently through the linguistic description of its grammar, which has emerged through the consensual laws from within its community, it gains political and national recognition through a country or region's policies. That is the stage when a language is considered a standard variety, one whose grammatical laws have now stabilised from within the consent of speech community participants, after sufficient evolution, improvisation, correction, and growth. The English language, besides perhaps the French language, may be examples of languages that have arrived at a stage where they are said to have become standard varieties.

The study of a language's universal properties, on the other hand, include some of the following concepts.

Lexicon

The lexicon is a catalogue of words and terms that are stored in a speaker's mind. The lexicon consists of words and bound morphemes, which are parts of words that can't stand alone, like affixes. In some analyses, compound words and certain classes of idiomatic expressions and other collocations are also considered to be part of the lexicon. Dictionaries represent attempts at listing, in alphabetical order, the lexicon of a given language; usually, however, bound morphemes are not included. Lexicography, closely linked with the domain of semantics, is the science of mapping the words into an encyclopedia or a dictionary. The creation and addition of new words (into the lexicon) is called coining or neologization,[34] and the new words are called neologisms.

It is often believed that a speaker's capacity for language lies in the quantity of words stored in the lexicon. However, this is often considered a myth by linguists. The capacity for the use of language is considered by many linguists to lie primarily in the domain of grammar, and to be linked with competence, rather than with the growth of vocabulary. Even a very small lexicon is theoretically capable of producing an infinite number of sentences.

Relativity

As constructed popularly through the Sapir–Whorf hypothesis, relativists believe that the structure of a particular language is capable of influencing the cognitive patterns through which a person shapes his or her world view. Universalists believe that there are commonalities between human perception as there is in the human capacity for language, while relativists believe that this varies from language to language and person to person. While the Sapir–Whorf hypothesis is an elaboration of this idea expressed through the writings of American linguists Edward Sapir and Benjamin Lee Whorf, it was Sapir's student Harry Hoijer who termed it thus. The 20th century German linguist Leo Weisgerber also wrote extensively about the theory of relativity. Relativists argue for the case of differentiation at the level of cognition and in semantic domains. The emergence of cognitive linguistics in the 1980s also revived an interest in linguistic relativity. Thinkers like George Lakoff have argued that language reflects different cultural metaphors, while the French philosopher of language Jacques Derrida's writings have been seen to be closely associated with the relativist movement in linguistics, especially through deconstruction[35] and was even heavily criticized in the media at the time of his death for his theory of relativism.[36]

Structures

Linguistic structures are pairings of meaning and form. Any particular pairing of meaning and form is a Saussurean sign. For instance, the meaning "cat" is represented worldwide with a wide variety of different sound patterns (in oral languages), movements of the hands and face (in sign languages), and written symbols (in written languages).

Linguists focusing on structure attempt to understand the rules regarding language use that native speakers know (not always consciously). All linguistic structures can be broken down into component parts that are combined according to (sub)conscious rules, over multiple levels of analysis. For instance, consider the structure of the word "tenth" on two different levels of analysis. On the level of internal word structure (known as morphology), the word "tenth" is made up of one linguistic form indicating a number and another form indicating ordinality. The rule governing the combination of these forms ensures that the ordinality marker "th" follows the number "ten." On the level of sound structure (known as phonology), structural analysis shows that the "n" sound in "tenth" is made differently from the "n" sound in "ten" spoken alone. Although most speakers of English are consciously aware of the rules governing internal structure of the word pieces of "tenth", they are less often aware of the rule governing its sound structure. Linguists focused on structure find and analyse rules such as these, which govern how native speakers use language.

Linguistics has many sub-fields concerned with particular aspects of linguistic structure. The theory that elucidates on these, as propounded by Noam Chomsky, is known as generative theory or universal grammar. These sub-fields range from those focused primarily on form to those focused primarily on meaning. They also run the gamut of level of analysis of language, from individual sounds, to words, to phrases, up to cultural discourse.

Grammar

Sub-fields that focus on a grammatical study of language include the following.

- **Phonetics**, the study of the physical properties of speech sound production and perception
- **Phonology**, the study of sounds as abstract elements in the speaker's mind that distinguish meaning (phonemes)
- **Morphology**, the study of morphemes, or the internal structures of words and how they can be modified
- **Syntax**, the study of how words combine to form grammatical phrases and sentences
- **Semantics**, the study of the meaning of words (lexical semantics) and fixed word combinations (phraseology), and how these combine to form the meanings of sentences
- **Pragmatics**, the study of how utterances are used in communicative acts, and the role played by context and non-linguistic knowledge in the transmission of meaning
- **Discourse analysis**, the analysis of language use in texts (spoken, written, or signed)
- **Stylistics**, the study of linguistic factors (rhetoric, diction, stress) that place a discourse in context
- **Semiotics**, the study of signs and sign processes (semiosis), indication, designation, likeness, analogy, metaphor, symbolism, signification, and communication.

TOC Previous Next

Style

Stylistics is the study and interpretation of texts for aspects of their linguistic and tonal style. Stylistic analysis entails the analysis of description of particular dialects and registers used by speech communities. Stylistic features include rhetoric,[37] diction, stress, satire, irony, dialogue, and other forms of phonetic variations.

Stylistic analysis can also include the study of language in canonical works of literature, popular fiction, news, advertisements, and other forms of communication in popular culture as well. It is usually seen as a variation in communication that changes from speaker to speaker and community to community. In short, Stylistics is the interpretation of text.

Approaches

TOC Previous Next

Theoretical

One major debate in linguistics concerns how language should be defined and understood. Some linguists use the term "language" primarily to refer to a hypothesized, innate module in the human brain that allows people to undertake linguistic behaviour, which is part of the formalist approach. This "universal grammar" is considered to guide children when they learn languages and to constrain what sentences are considered grammatical in any language. Proponents of this view, which is predominant in those schools of linguistics that are based on the generative theory of Noam Chomsky, do not necessarily consider that language evolved for communication in particular. They consider instead that it has more to do with the process of structuring human thought (see also formal grammar).

TOC Previous Next

Functional

Another group of linguists, by contrast, use the term "language" to refer to a communication system that developed to support cooperative activity and extend cooperative networks. Such theories of grammar, called "functional", view language as a tool that emerged and is adapted to the communicative needs of its users, and the role of cultural evolutionary processes are often emphasized over that of biological evolution.[38]

TOC Previous Next

Methodology

Linguistics is primarily descriptive. Linguists describe and explain features of language without making subjective judgments on whether a particular feature or usage is "good" or "bad". This is analogous to practice in other sciences: a zoologist studies the animal kingdom without making subjective judgments on whether a particular species is "better" or "worse" than another.

Prescription, on the other hand, is an attempt to promote particular linguistic usages over others, often favouring a particular dialect or " acrolect". This may have the aim of establishing a linguistic standard, which can aid communication over large geographical areas. It may also, however, be an attempt by speakers of one language or dialect to exert influence over speakers of other languages or dialects (see Linguistic imperialism). An extreme version of prescriptivism can be found among censors, who attempt to eradicate words and structures that they consider to be destructive to society. Prescription, however, may be practised appropriately in the teaching of language, like in ELT, where certain fundamental grammatical rules and lexical terms need to be introduced to a second-language speaker who is attempting to acquire the language.

TOC Previous Next

Anthropology

The objective of describing languages is often to uncover cultural knowledge about communities. The use of anthropological methods of investigation on linguistic sources leads to the discovery of certain cultural traits among a speech community through its linguistic features. It is also widely used as a tool in language documentation, with an endeavour to curate endangered languages. However, now, linguistic inquiry uses the anthropological method to understand cognitive, historical, sociolinguistic and historical processes that languages undergo as they change and evolve, as well as general anthropological inquiry uses the linguistic method to

excavate into culture. In all aspects, anthropological inquiry usually uncovers the different variations and relativities that underlie the usage of language.

TOC Previous Next

Sources

Most contemporary linguists work under the assumption that spoken data and signed data are more fundamental than written data. This is because

- Speech appears to be universal to all human beings capable of producing and perceiving it, while there have been many cultures and speech communities that lack written communication;
- Features appear in speech which aren't always recorded in writing, including phonological rules, sound changes, and speech errors;
- All natural writing systems reflect a spoken language (or potentially a signed one), even with pictographic scripts like Dongba writing Naxi homophones with the same pictogram, and text in writing systems used for two languages changing to fit the spoken language being recorded;
- Speech evolved before human beings invented writing;
- People learnt to speak and process spoken language more easily and earlier than they did with writing.

Nonetheless, linguists agree that the study of written language can be worthwhile and valuable. For research that relies on corpus linguistics and computational linguistics, written language is often much more convenient for processing large amounts of linguistic data. Large corpora of spoken language are difficult to create and hard to find, and are typically transcribed and written. In addition, linguists have turned to text-based discourse occurring in various formats of computer-mediated communication as a viable site for linguistic inquiry.

The study of writing systems themselves, graphemics, is, in any case,

considered a branch of linguistics.

Analysis

Before the 20th century, linguists analysed language on a diachronic plane, which was historical in focus. This meant that they would compare linguistic features and try to analyse language from the point of view of how it had changed between then and later. However, with Saussurean linguistics in the 20th century, the focus shifted to a more synchronic approach, where the study was more geared towards analysis and comparison between different language variations, which existed at the same given point of time.

At another level, the syntagmatic plane of linguistic analysis entails the comparison between the way words are sequenced, within the syntax of a sentence. For example, the article "the" is followed by a noun, because of the syntagmatic relation between the words. The paradigmatic plane on the other hand, focuses on an analysis that is based on the paradigms or concepts that are embedded in a given text. In this case, words of the same type or class may be replaced in the text with each other to achieve the same conceptual understanding.

History

Main article: History of linguistics

TOC Previous Next

Early grammarians

Main articles: Philology and History of English grammars

The formal study of language began in India with Pāṇini, the 6th century BC grammarian who formulated 3,959 rules of Sanskrit morphology. Pāṇini's systematic classification of the sounds of Sanskrit into consonants and vowels, and word classes, such as nouns and verbs, was the first known instance of its kind. In the Middle East, Sibawayh, a non-Arab, made a detailed description of Arabic in AD 760 in his monumental work, *Al-kitab fi al-nahw* (الكتاب في النحو, *The Book on Grammar*), the first known author to distinguish between sounds and phonemes (sounds as units of a linguistic system). Western interest in the study of languages began somewhat later than in the East,[39] but the grammarians of the classical languages did not use the same methods or reach the same conclusions as their contemporaries in the Indic world. Early interest in language in the West was a part of philosophy, not of grammatical description. The first insights into semantic theory were made by Plato in his *Cratylus* dialogue, where he argues that words denote concepts that are eternal and exist in the world of ideas. This work is the first to use the word etymology to describe the history of a word's meaning. Around 280 BC, one of Alexander the Great's successors founded a university (see Musaeum) in Alexandria, where a school of philologists studied the ancient texts in and taught Greek to speakers of other languages. While this school was the first to use the word "grammar" in its modern sense, Plato had used the word in its original meaning as "téchnē grammatikḗ" (Τέχνη Γραμματική), the "art of writing", which is also the title of one of the most important works of the Alexandrine school by Dionysius Thrax.[40] Throughout the Middle

Ages, the study of language was subsumed under the topic of philology, the study of ancient languages and texts, practised by such educators as Roger Ascham, Wolfgang Ratke, and John Amos Comenius.[41]

TOC | Previous | Next

Comparative philology

In the 18th century, the first use of the comparative method by William Jones sparked the rise of comparative linguistics.[42] Bloomfield attributes "the first great scientific linguistic work of the world" to Jacob Grimm, who wrote *Deutsche Grammatik*.[43] It was soon followed by other authors writing similar comparative studies on other language groups of Europe. The study of language was broadened from Indo-European to language in general by Wilhelm von Humboldt, of whom Bloomfield asserts:[43]

TOC | Previous | Next

Structuralism

Main article: Structuralism (linguistics)

Early in the 20th century, Saussure introduced the idea of language as a static system of interconnected units, defined through the oppositions between them. By introducing a distinction between diachronic and synchronic analyses of language, he laid the foundation of the modern discipline of linguistics. Saussure also introduced several basic dimensions of linguistic analysis that are still foundational in many contemporary linguistic theories, such as the distinctions between syntagm and paradigm, and the langue- parole distinction, distinguishing language as an abstract system (*langue*) from language as a concrete manifestation of this system (*parole*).[44] Substantial additional contributions following Saussure's definition of a structural approach to language came from The Prague school, Leonard Bloomfield, Charles F. Hockett, Louis Hjelmslev, Émile Benveniste and Roman Jakobson.[45][46]

TOC | Previous | Next

Generativism

Main article: Generative linguistics

During the last half of the 20th century, following the work of Noam Chomsky, linguistics was dominated by the generativist school. While formulated by Chomsky in part as a way to explain how human beings acquire language and the biological constraints on this acquisition, in practice it has largely been concerned with giving formal accounts of specific phenomena in natural languages. Generative theory is modularist and formalist in character. Chomsky built on earlier work of Zellig Harris to formulate the generative theory of language. According to this theory the most basic form of language is a set of syntactic rules universal for all humans and underlying the grammars of all human languages. This set of rules is called Universal Grammar, and for Chomsky describing it is

the primary objective of the discipline of linguistics. For this reason the grammars of individual languages are of importance to linguistics only in so far as they allow us to discern the universal underlying rules from which the observable linguistic variability is generated.

In the classic formalization of generative grammars first proposed by Noam Chomsky in the 1950s,[47][48] a grammar *G* consists of the following components:

- A finite set *N* of *nonterminal symbols*, none of which appear in strings formed from *G*.
- A finite set of *terminal symbols* that is disjoint from *N*.
- A finite set *P* of *production rules*, that map from one string of symbols to another.

A formal description of language attempts to replicate a speaker's knowledge of the rules of their language, and the aim is to produce a set of rules that is minimally sufficient to successfully model valid linguistic forms.

TOC | Previous | Next

Functionalism

Main article: Functional theories of grammar

Functional theories of language propose that since language is fundamentally a tool, it is reasonable to assume that its structures are best analysed and understood with reference to the functions they carry out. Functional theories of grammar differ from formal theories of grammar, in that the latter seek to define the different elements of language and describe the way they relate to each other as systems of formal rules or operations, whereas the former defines the functions performed by language and then relates these functions to the linguistic elements that carry them out. This means that functional theories of grammar tend to pay attention to the way language is actually used, and not just to the formal relations between linguistic elements.[49]

Functional theories describe language in term of the functions existing at all levels of language.

- Phonological function: the function of the phoneme is to distinguish between different lexical material.
- Semantic function: (Agent, Patient, Recipient, etc.), describing the role of participants in states of affairs or actions expressed.
- Syntactic functions: (e.g. Subject and Object), defining different perspectives in the presentation of a linguistic expression
- Pragmatic functions: (Theme and Rheme, Topic and Focus, Predicate), defining the informational status of constituents, determined by the pragmatic context of the verbal interaction. Functional descriptions of grammar strive to explain how linguistic functions are performed in

communication through the use of linguistic forms.

Cognitive linguistics

Main article: Cognitive linguistics

Cognitive linguistics emerged as a reaction to generativist theory in the 1970s and 1980s. Led by theorists like Ronald Langacker and George Lakoff, cognitive linguists propose that language is an emergent property of basic, general-purpose cognitive processes. In contrast to the generativist school of linguistics, cognitive linguistics is non-modularist and functionalist in character. Important developments in cognitive linguistics include cognitive grammar, frame semantics, and conceptual metaphor, all of which are based on the idea that form–function correspondences based on representations derived from embodied experience constitute the basic units of language.

Cognitive linguistics interprets language in terms of concepts (sometimes universal, sometimes specific to a particular tongue) that underlie its form. It is thus closely associated with semantics but is distinct from psycholinguistics, which draws upon empirical findings from cognitive psychology in order to explain the mental processes that underlie the acquisition, storage, production and understanding of speech and writing. Unlike generative theory, cognitive linguistics denies that there is an *autonomous linguistic faculty* in the mind; it understands grammar in terms of *conceptualization*; and claims that knowledge of language arises out of *language use*.[50] Because of its conviction that knowledge of language is learned through use, cognitive linguistics is sometimes considered to be a functional approach, but it differs from other functional approaches in that it is primarily concerned with how the mind creates meaning through language, and not with the use of language as a tool of communication.

Areas of research

TOC ← Previous Next →

Historical linguistics

Historical linguists study the history of specific languages as well as general characteristics of language change. The study of language change is also referred to as "diachronic linguistics" (the study of how one particular language has changed over time), which can be distinguished from "synchronic linguistics" (the comparative study of more than one language at a given moment in time without regard to previous stages). Historical linguistics was among the first sub-disciplines to emerge in linguistics, and was the most widely practised form of linguistics in the late 19th century. However, there was a shift to the synchronic approach in the early twentieth century with Saussure, and became more predominant in western linguistics with the work of Noam Chomsky.

TOC ← Previous Next →

Ecolinguistics

Ecolinguistics explores the role of language in the life-sustaining interactions of humans, other species and the physical environment. The first aim is to develop linguistic theories which see humans not only as part of society, but also as part of the larger ecosystems that life depends on. The second aim is to show how linguistics can be used to address key ecological issues, from climate change and biodiversity loss to environmental justice.[51]

TOC ← Previous Next →

Sociolinguistics

Sociolinguistics is the study of how language is shaped by social factors. This sub-discipline focuses on the synchronic approach of linguistics, and looks at how a language in general, or a set of languages, display variation and varieties at a given point in time. The study of language variation and the different varieties of language through dialects, registers, and ideolects can be tackled through a study of style, as well as through analysis of discourse. Sociolinguists research on both style and discourse in language, and also study the theoretical factors that are at play between language and society.

TOC ← Previous Next →

Developmental linguistics

Developmental linguistics is the study of the development of linguistic ability in individuals, particularly the acquisition of language in childhood. Some of the questions that developmental linguistics looks into is how children acquire different languages, how adults can acquire a second

language, and what the process of language acquisition is.

☰ TOC | ← Previous | Next →

Neurolinguistics

Neurolinguistics is the study of the structures in the human brain that underlie grammar and communication. Researchers are drawn to the field from a variety of backgrounds, bringing along a variety of experimental techniques as well as widely varying theoretical perspectives. Much work in neurolinguistics is informed by models in psycholinguistics and theoretical linguistics, and is focused on investigating how the brain can implement the processes that theoretical and psycholinguistics propose are necessary in producing and comprehending language. Neurolinguists study the physiological mechanisms by which the brain processes information related to language, and evaluate linguistic and psycholinguistic theories, using aphasiology, brain imaging, electrophysiology, and computer modelling. Amongst the structures of the brain involved in the mechanisms of neurolinguistics, the cerebellum which contains the highest numbers of neurons has a major role in terms of predictions required to produce language.[52]

☰ TOC | ← Previous | Next →

Applied linguistics

Main article: Applied linguistics

Linguists are largely concerned with finding and describing the generalities and varieties both within particular languages and among all languages. Applied linguistics takes the results of those findings and "applies" them to other areas. Linguistic research is commonly applied to areas such as language education, lexicography, translation, language planning, which involves governmental policy implementation related to language use, and natural language processing. "Applied linguistics" has been argued to be something of a misnomer.[53] Applied linguists actually focus on making sense of and engineering solutions for real-world linguistic problems, and not literally "applying" existing technical knowledge from linguistics. Moreover, they commonly apply technical knowledge from multiple sources, such as sociology (e.g., conversation analysis) and anthropology. (Constructed language fits under Applied linguistics.)

Today, computers are widely used in many areas of applied linguistics. Speech synthesis and speech recognition use phonetic and phonemic knowledge to provide voice interfaces to computers. Applications of computational linguistics in machine translation, computer-assisted translation, and natural language processing are areas of applied linguistics that have come to the forefront. Their influence has had an effect on theories of syntax and semantics, as modelling syntactic and semantic theories on computers constraints.

Linguistic analysis is a sub-discipline of applied linguistics used by many governments to verify the claimed nationality of people seeking asylum who do not hold the necessary documentation to prove their claim.[54] This often takes the form of an interview by personnel in an immigration department. Depending on the country, this interview is conducted either in the asylum seeker's native language through an interpreter or in an international *lingua franca* like English.[54] Australia uses the former method, while Germany employs the latter; the Netherlands uses either method depending on the languages involved.[54] Tape recordings of the interview then undergo language analysis, which can be done either by private contractors or within a department of the government. In this analysis, linguistic features of the asylum seeker are used by analysts to make a determination about the speaker's nationality. The reported findings of the linguistic analysis can play a critical role in the government's decision on the refugee status of the asylum seeker.[54]

Interdisciplinary fields

Within the broad discipline of linguistics, various emerging sub-disciplines focus on a more detailed description and analysis of language, and are often organized on the basis of the school of thought and theoretical approach that they pre-suppose, or the external factors that influence them.

TOC | Previous | Next

Semiotics

Semiotics is the study of sign processes (semiosis), or signification and communication, signs, and symbols, both individually and grouped into sign systems, including the study of how meaning is constructed and understood. Semioticians often do not restrict themselves to linguistic communication when studying the use of signs but extend the meaning of "sign" to cover all kinds of cultural symbols. Nonetheless, semiotic disciplines closely related to linguistics are literary studies, discourse analysis, text linguistics, and philosophy of language. Semiotics, within the linguistics paradigm, is the study of the relationship between language and culture. Historically, Edward Sapir and Ferdinand De Saussure's structuralist theories influenced the study of signs extensively until the late part of the 20th century, but later, post-modern and post-structural thought, through language philosophers including Jacques Derrida, Mikhail Bakhtin, Michel Foucault, and others, have also been a considerable influence on the discipline in the late part of the 20th century and early 21st century.[55] These theories emphasize the role of language variation, and the idea of subjective usage, depending on external elements like social and cultural factors, rather than merely on the interplay of formal elements.

TOC | Previous | Next

Language documentation

Since the inception of the discipline of linguistics, linguists have been concerned with describing and analysing previously undocumented languages. Starting with Franz Boas in the early 1900s, this became the main focus of American linguistics until the rise of formal structural linguistics in the mid-20th century. This focus on language documentation was partly motivated by a concern to document the rapidly disappearing languages of indigenous peoples. The ethnographic dimension of the Boasian approach to language description played a role in the development of disciplines such as sociolinguistics, anthropological linguistics, and linguistic anthropology, which investigate the relations between language, culture, and society.

The emphasis on linguistic description and documentation has also gained prominence outside North America, with the documentation of rapidly dying indigenous languages becoming a primary focus in

many university programmes in linguistics. Language description is a work-intensive endeavour, usually requiring years of field work in the language concerned, so as to equip the linguist to write a sufficiently accurate reference grammar. Further, the task of documentation requires the linguist to collect a substantial corpus in the language in question, consisting of texts and recordings, both sound and video, which can be stored in an accessible format within open repositories, and used for further research.[56]

TOC ← Previous Next →

Translation

The sub-field of translation includes the translation of written and spoken texts across mediums, from digital to print and spoken. To translate literally means to transmute the meaning from one language into another. Translators are often employed by organizations, such as travel agencies as well as governmental embassies to facilitate communication between two speakers who do not know each other's language. Translators are also employed to work within computational linguistics setups like Google Translate for example, which is an automated, programmed facility to translate words and phrases between any two or more given languages. Translation is also conducted by publishing houses, which convert works of writing from one language to another in order to reach varied audiences. Academic Translators, specialize and semi specialize on various other disciplines such as; Technology, Science, Law, Economics etc.

TOC ← Previous Next →

Biolinguistics

Biolinguistics is the study of the biology and evolution of language. It is a highly interdisciplinary field, including linguists, biologists, neuroscientists, psychologists, mathematicians, and others. By shifting the focus of investigation in linguistics to a comprehensive scheme that embraces natural sciences, it seeks to yield a framework by which the fundamentals of the faculty of language are understood.

TOC ← Previous Next →

Clinical linguistics

Clinical linguistics is the application of linguistic theory to the fields of Speech-Language Pathology. Speech language pathologists work on corrective measures to cure communication disorders and swallowing disorders

Chaika (1990) showed that schizophrenics with speech disorders, like rhyming inappropriately, have attentional dysfunction, as when a patient, shown a colour chip and, then asked to identify it, responded "Looks like clay. Sounds like gray. Take you for a roll in the hay. Heyday, May Day." The color chip

was actually clay-colored, so his first response was correct.'

However, normals suppress or ignore words which rhyme with what they've said unless they are deliberately producing a pun, poem or rap. Even then, the speaker shows connection between words chosen for rhyme and an overall meaning in discourse. schizophrenics with speech dysfunction show no such relation between rhyme and reason. Some even produce stretches of gibberish combined with recognizable words.[57]

☰ TOC | ← Previous | Next →

Computational linguistics

Computational linguistics is the study of linguistic issues in a way that is "computationally responsible", i.e., taking careful note of computational consideration of algorithmic specification and computational complexity, so that the linguistic theories devised can be shown to exhibit certain desirable computational properties and their implementations. Computational linguists also work on computer language and software development.

☰ TOC | ← Previous | Next →

Evolutionary linguistics

Evolutionary linguistics is the interdisciplinary study of the emergence of the language faculty through human evolution, and also the application of evolutionary theory to the study of cultural evolution among different languages. It is also a study of the dispersal of various languages across the globe, through movements among ancient communities.[58]

☰ TOC | ← Previous | Next →

Forensic linguistics

Forensic linguistics is the application of linguistic analysis to forensics. Forensic analysis investigates on the style, language, lexical use, and other linguistic and grammatical features used in the legal context to provide evidence in courts of law. Forensic linguists have also contributed expertise in criminal cases.

☰ TOC | ← Previous | Next →

See also

Main articles: Outline of linguistics and Index of linguistics articles

- Anthroponymy
- Articulatory phonology
- Articulatory synthesis
- Asemic writing
- Axiom of categoricity
- Biosemiotics
- Cognitive science
- Concept mining
- Critical discourse analysis
- Cryptanalysis
- Decipherment
- Global language system
- Grammarian (Greco-Roman world)
- Integrational linguistics
- Integrationism
- Intercultural competence
- International Congress of Linguists
- International Linguistics Olympiad
- Language attrition
- Language engineering
- Language geography
- Linguistic typology
- List of departments of linguistics
- List of summer schools of linguistics
- Metacommunicative competence
- Microlinguistics
- Onomastics
- Reading
- Rhythm § Linguistics
- Speaker recognition

- Speech processing
- Stratificational linguistics

References

1. ^ Halliday, Michael A.K.; Jonathan Webster (2006). *On Language and Linguistics*. Continuum International Publishing Group. p. vii. ISBN 0-8264-8824-2.
2. ^ Martinet, André (1960). *Elements of General Linguistics*. Studies in General Linguistics, vol. i. Translated by Elisabeth Palmer Rubbert. London: Faber. p. 15.
3. ^ Rens Bod (2014). *A New History of the Humanities: The Search for Principles and Patterns from Antiquity to the Present*. Oxford University Press. ISBN 0199665214.
4. ^ "Chapter VI: Sanskrit Literature". *The Imperial Gazetteer of India*. **2**. 1908. p. 263.
5. ^ S.C. Vasu (Tr.) (1996). *The Ashtadhyayi of Panini (2 Vols.)*. Vedic Books. ISBN 9788120804098.
6. ^ Jakobson, Roman (1937). *Six Lectures on Sound and Meaning*. MIT Press, Cambridge, Massachusetts. ISBN 0262600102.
7. ^ Sharada Narayanan (2010). *Vakyapadiya: Sphota, Jati, and Dravya*.
8. ^ Chierchia, Gennaro & Sally McConnell-Ginet (2000). *Meaning and Grammar: An Introduction to Semantics*. MIT Press, Cambridge, Massachusetts. ISBN 9780262531641.
9. ^ All references in this article to the study of sound should be taken to include the manual and non-manual signs used in sign languages.
10. ^ Adrian Akmajian; Richard A. Demers; Ann K. Farmer; Robert M. Harnish (2010). *Linguistics* (6th ed.). The MIT Press. ISBN 0-262-51370-6. Retrieved 25 July 2012.
11. ^ *Syntax: A Generative Introduction* (Second Edition), 2013. Andrew Carnie. Blackwell Publishing.
12. ^ de Saussure, F. (1986). *Course in general linguistics* (3rd ed.). (R. Harris, Trans.). Chicago: Open Court Publishing Company. (Original work published 1972). p. 9-10, 15.
13. ^ Chomsky, Noam. (1965). *Aspects of the Theory of Syntax*. Cambridge, MA: MIT Press.
14. ^ Raymond Mougeon & Terry Nadasdi (1998). *Sociolinguistic Discontinuity in Minority Language Communities*. Linguistic Society of America. pp. 40–55. JSTOR 417564.
15. ^ "Stylistics" by Joybrato Mukherjee. Chapter 49. *Encyclopedia of Linguistics* .
16. ^ Writing and Difference by Jacques Derrida, 1967, and Of Grammatology
17. ^ Chapter 1, section 1.1 in Elmer H. Antonsen (2002). *Trends in Linguistics: Runes and Germanic Linguistics* (6th ed.). Mouton de Gruyter. ISBN 3-11-017462-6.
18. ^ Journal of Language and Politics
19. ^ [a] [b] Harper, Douglas. "philology". *Online Etymology Dictionary*. Retrieved 2018-03-05.
20. ^ Nichols, Stephen G. (1990). "Introduction: Philology in a Manuscript Culture". *Speculum*. **65**

(1): 1–10. doi:10.2307/2864468. JSTOR 2864468.

21. ^ McMahon, A. M. S. (1994). *Understanding Language Change*. Cambridge University Press. p. 19. ISBN 0-521-44665-1.
22. ^ McMahon, A. M. S. (1994). *Understanding Language Change*. Cambridge University Press. p. 9. ISBN 0-521-44665-1.
23. ^ A. Morpurgo Davies Hist. Linguistics (1998) 4 I. 22.
24. ^ *a b* Harper, Douglas. "linguist". *Online Etymology Dictionary*. Retrieved 2018-03-05.
25. ^ Spolsky, Bernard; Hult, Francis M. (February 2010). *The Handbook of Educational Linguistics*. John Wiley & Sons. ISBN 9781444331042.
26. ^ Berns, Margie (2010-03-20). *Concise Encyclopedia of Applied Linguistics*. Elsevier. pp. 23–25. ISBN 9780080965031.
27. ^ "The Science of Linguistics". *Linguistic Society of America*. Retrieved 2018-04-17. "Modern linguists approach their work with a scientific perspective, although they use methods that used to be thought of as solely an academic discipline of the humanities. Contrary to previous belief, linguistics is multidisciplinary. It overlaps each of the human sciences including psychology, neurology, anthropology, and sociology. Linguists conduct formal studies of sound structure, grammar and meaning, but they also investigate the history of language families, and research language acquisition."
28. ^ Crystal, David (1990). *Linguistics*. Penguin Books. ISBN 9780140135312.
29. ^ "Linguist". *The American Heritage Dictionary of the English Language*. Houghton Mifflin Harcourt. 2000. ISBN 978-0-395-82517-4.
30. ^ Oxford English dictionary.
31. ^ Trudgill, P. (1994). Dialects. *Ebooks Online* Routledge. Florence, KY.
32. ^ Ariel, Mira (2009). "Discourse, grammar, discourse". *Discourse Studies*. **11** (1): 5–36. JSTOR 24049745.
33. ^ Helen Leckie-Tarry, *Language and Context: a Functional Linguistic Theory of Register*, Continuum International Publishing Group, 1995, p. 6. ISBN 1-85567-272-3
34. ^ Zuckermann, Ghil'ad (2003). *Language Contact and Lexical Enrichment in Israeli Hebrew*. Palgrave Macmillan. pp. 2ff. ISBN 978-1403917232.
35. ^ Jacques Derrida (1978). *Writing and Difference*. Translated by Alan Bass. University of Chicago Press. ISBN 9780226143293.
36. ^ Lea, Richard (18 November 2004). "Relative Thinking". *The Guardian*.
37. ^ IA Richards (1965). *The Philosophy of Rhetoric*. Oxford University Press (New York).
38. ^ Isac, Daniela; Charles Reiss (2013). *I-language: An Introduction to Linguistics as Cognitive*

Science, 2nd edition. Oxford University Press. ISBN 978-0199660179.
39. ^ Bloomfield 1983, p. 307.
40. ^ Seuren, Pieter A. M. (1998). *Western linguistics: An historical introduction*. Wiley-blackwell. pp. 2–24. ISBN 0-631-20891-7.
41. ^ Bloomfield 1983, p. 308.
42. ^ Bloomfield 1983, p. 310.
43. ^ *a b* Bloomfield 1983, p. 311.
44. ^ Clarke, David S. (1990). *Sources of Semiotic: Readings with Commentary from Antiquity to the Present*. Carbondale: Southern Illinois University Press. pp. 143–144. ISBN 9780809316144.
45. ^ Holquist 1981, pp. xvii–xviii.[*citation not found*]
46. ^ de Saussure, Ferdinand. *Course in General Linguistics*. New York: McGraw Hill. ISBN 0-8022-1493-2.
47. ^ Chomsky, Noam (1956). "Three Models for the Description of Language". *IRE Transactions on Information Theory*. **2** (2): 113 123. doi:10.1109/TIT.1956.1056813.
48. ^ Chomsky, Noam (1957). *Syntactic Structures*. The Hague: Mouton.
49. ^ Nichols, Johanna (1984). "Functional Theories of Grammar". *Annual Review of Anthropology*. **13**: 97–117. doi:10.1146/annurev.an.13.100184.000525. "[Functional grammar] analyzes grammatical structure, as do formal and structural grammar; but it also analyses the entire communicative situation: the purpose of the speech event, its participants, its discourse context. Functionalists maintain that the communicative situation motivates, constrains, explains, or otherwise determines grammatical structure, and that a structural or formal approach is not merely limited to an artificially restricted data base, but is inadequate as a structural account. Functional grammar, then, differs from formulae and structural grammar in that it purports not to model but to explain; and the explanation is grounded in the communicative situation."
50. ^ Croft, William & D. Alan Cruse (2004). *Cognitive Linguistics*. Cambridge: Cambridge University Press. p. 1.
51. ^ "Ecolinguistics Association".
52. ^ Mariën, Peter; Manto, Mario (2017-10-25). "Cerebellum as a Master-Piece for Linguistic Predictability". *Cerebellum (London, England)*. doi:10.1007/s12311-017-0894-1. ISSN 1473-4230. PMID 29071518.
53. ^ Barbara Seidlhofer (2003). *Controversies in Applied Linguistics (pp. 288)*. Oxford University Press. ISBN 0194374440.
54. ^ *a b c d* Eades, Diana (2005). "Applied Linguistics and Language Analysis in Asylum Seeker

Cases" (PDF). *Applied Linguistics*. **26** (4): 503–526. doi:10.1093/applin/ami021.

55. ^ Miller, Paul Allen (1998). "The Classical Roots of Post-Structuralism: Lacan, Derrida and Foucault". *International Journal of the Classical Tradition*. Springer. **5** (2): 204–225. doi:10.1007/bf02688423. JSTOR 30222818.
56. ^ Himmelman, Nikolaus "Language documentation: What is it and what is it good for?" in P. Gippert, Jost, Nikolaus P Himmelmann & Ulrike Mosel. (2006) *Essentials of Language documentation*. Mouton de Gruyter, Berlin & New York.
57. ^ Chaika, Elaine Ostrach. 1990. Understanding Psychotic Speech: Between Freud and Chomsky. Chas. Thomas Publishers.
58. ^ Croft, William (October 2008). "Evolutionary Linguistics". *Annual Review of Anthropology*. Annual Reviews. **37**: 219–234. doi:10.1146/annurev.anthro.37.081407.085156.

Bibliography

- Akmajian, Adrian; Demers, Richard; Farmer, Ann; Harnish, Robert (2010). *Linguistics: An Introduction to Language and Communication*. Cambridge, MA: The MIT Press. ISBN 0-262-51370-6.
- Bloomfield, Leonard (1983) [1914]. *An Introduction to the Study of Language: New edition*. Amsterdam: John Benjamins Publishing. ISBN 90-272-8047-9.
- Isac, Daniela; Charles Reiss (2013). *I-language: An Introduction to Linguistics as Cognitive Science, 2nd edition*. Oxford University Press. ISBN 978-0199660179.
- Pinker, Steven (1994). *The Language Instinct*. William Morrow and Company. ISBN 9780140175295.
- Chomsky, Noam (1998). *On Language*. The New Press, New York. ISBN 978-1565844759.
- Derrida, Jacques (1967). *Of Grammatology*. The Johns Hopkins University Press. ISBN 0801858305.
- Crystal, David (1990). *Linguistics*. Penguin Books. ISBN 9780140135312.
- Hall, Christopher (2005). *An Introduction to Language and Linguistics. Breaking the Language Spell*. Routledge. ISBN 9780826487346.

External links

- The Linguist List, a global online linguistics community with news and information updated daily
- Glossary of linguistic terms by SIL International (last updated 2004)
- Glottopedia, MediaWiki-based encyclopedia of linguistics, under construction
- Linguistic sub-fields – according to the Linguistic Society of America
- Linguistics and language-related wiki articles on Scholarpedia and Citizendium
- "Linguistics" section – A Bibliography of Literary Theory, Criticism and Philology, ed. J. A. García Landa (University of Zaragoza, Spain)
- Isac, Daniela; Charles Reiss (2013). *I-language: An Introduction to Linguistics as Cognitive Science, 2nd edition*. Oxford University Press. ISBN 978-0-19-953420-3.
- Linguistics at Curlie (based on DMOZ)

Categories: Linguistics | Cognitive science | Language

This page was last edited on 8 June 2018, at 03:35.

Back to main TOC

Contents

Cognition

Jump to navigation Jump to search
This article is about the mental process. For the journal, see Cognition (journal).
See also: Animal cognition
"Cognitive" redirects here. For other uses, see Cognitive (disambiguation).

Cognition is "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses".[1] It encompasses processes such as attention, the formation of knowledge, memory and working memory, judgment and evaluation, reasoning and " computation", problem solving and decision making, comprehension and production of language. Cognitive processes use existing knowledge and generate new knowledge.

The processes are analyzed from different perspectives within different contexts, notably in the fields of linguistics, anesthesia, neuroscience, psychiatry, psychology, education, philosophy, anthropology, biology, systemics, logic, and computer science.[2] These and other different approaches to the analysis of cognition are synthesised in the developing field of cognitive science, a progressively autonomous academic discipline.

TOP

TOC Next

Etymology

The word *cognition* comes from the Latin verb *cognosco* (*con*, 'with', and *gnōscō*, 'know'; itself a cognate of the Greek verb γι(γ)νώσκω, *gi(g)nósko*, meaning 'I know, perceive'), meaning 'to conceptualize' or 'to recognize'.[3]

TOC Previous Next

The beginnings of the studies on cognition

Cognition is a word that dates back to the 15th century, when it meant "thinking and awareness".[4] Attention to the cognitive process came about more than eighteen centuries ago, beginning with Aristotle and his interest in the inner workings of the mind and how they affect the human experience. Aristotle focused on cognitive areas pertaining to memory, perception, and mental imagery. The Greek philosopher found great importance in ensuring that his studies were based on empirical evidence; scientific information that is gathered through observation and conscientious experimentation.[5] Centuries later, as psychology became a burgeoning field of study in Europe and then gained a following in America, other scientists like Wilhelm Wundt, Herman Ebbinghaus, Mary Whiton Calkins, and William James would offer their contributions to the study of human cognition.

Wilhelm Wundt emphasized the notion of what he called introspection: examining the inner feelings of an individual. With introspection, the subject had to be careful to describe his or her feelings in the most objective manner possible in order for Wundt to find the information scientific.[6][7] Though Wundt's contributions are by no means minimal, modern psychologists find his methods to be quite subjective and choose to rely on more objective procedures of experimentation to make conclusions about the human cognitive process.

Hermann Ebbinghaus (1850–1909) conducted cognitive studies that mainly examined the function and capacity of human memory. Ebbinghaus developed his own experiment in which he constructed over 2,000 syllables made out of nonexistent words, for instance EAS. He then examined his own personal ability to learn these non-words. He purposely chose non-words as opposed to real words to control for the influence of pre-existing experience on what the words might symbolize, thus enabling easier recollection of them.[6][8] Ebbinghaus observed and hypothesized a number of variables that may have affected his ability to learn and recall the non-words he created. One of the reasons, he concluded, was the

amount of time between the presentation of the list of stimuli and the recitation or recall of same. Ebbinghaus was the first to record and plot a "learning curve," and a "forgetting curve."[9] His work heavily influenced the study of serial position and its effect on memory, discussed in subsequent sections.

Mary Whiton Calkins (1863–1930) was an influential American pioneer in the realm of psychology. Her work also focused on the human memory capacity. A common theory, called the recency effect, can be attributed to the studies that she conducted.[10] The recency effect, also discussed in the subsequent experiment section, is the tendency for individuals to be able to accurately recollect the final items presented in a sequence of stimuli. Calkin's theory is closely related to the aforementioned study and conclusion of the memory experiments conducted by Hermann Ebbinghaus.[11]

William James (1842–1910) is another pivotal figure in the history of cognitive science. James was quite discontent with Wundt's emphasis on introspection and Ebbinghaus' use of nonsense stimuli. He instead chose to focus on the human learning experience in everyday life and its importance to the study of cognition. James' most significant contribution to the study and theory of cognition was his textbook *Principles of Psychology* that preliminarily examines aspects of cognition such as perception, memory, reasoning, and attention.[11]

In psychology

In psychology, the term "cognition" is usually used within an information processing view of an individual's psychological functions (see cognitivism),[12] and it is the same in cognitive engineering;[13] in a branch of social psychology called social cognition, the term is used to explain attitudes, attribution, and group dynamics.[12]

Human cognition is conscious and unconscious, concrete or abstract, as well as intuitive (like knowledge of a language) and conceptual (like a model of a language). It encompasses processes such as memory, association, concept formation, pattern recognition, language, attention, perception, action, problem solving and mental imagery.[14][15] Traditionally, emotion was not thought of as a cognitive process, but now much research is being undertaken to examine the cognitive psychology of emotion; research is also focused on one's awareness of one's own strategies and methods of cognition, which is called metacognition.

While few people would deny that cognitive processes are a function of the brain, a cognitive theory will not necessarily make reference to the brain or to biological processes (compare neurocognitive). It may purely describe behavior in terms of information flow or function. Relatively recent fields of study such as the neuropsychology aim to bridge this gap, using cognitive paradigms to understand how the brain implements the information-processing functions (see also cognitive neuroscience), or to understand how pure information-processing systems (e.g., computers) can simulate human cognition (see also artificial intelligence). The branch of psychology that studies brain injury to infer normal cognitive function is called cognitive neuropsychology. The links of cognition to evolutionary demands are studied through the investigation of animal cognition.

Piaget's theory of cognitive development

For years, sociologists and psychologists have conducted studies on cognitive development or the construction of human thought or mental processes.

Jean Piaget was one of the most important and influential people in the field of Developmental Psychology. He believed that humans are unique in comparison to animals because we have the capacity to do "abstract symbolic reasoning." His work can be compared to Lev Vygotsky, Sigmund Freud, and Erik Erikson who were also great contributors in the field of Developmental Psychology. Today, Piaget is known for studying the cognitive development in children. He studied his own three children and their intellectual development and came up with a theory that describes the stages children pass through during development.[16]

Common experiments on human cognition

Serial position

The serial position experiment is meant to test a theory of memory that states that when information is given in a serial manner, we tend to remember information in the beginning of the sequence, called the primacy effect, and information in the end of the sequence, called the recency effect. Consequently, information given in the middle of the sequence is typically forgotten, or not recalled as easily. This study predicts that the recency effect is stronger than the primacy effect, because the information that is most recently learned is still in working memory when asked to be recalled. Information that is learned first still has to go through a retrieval process. This experiment focuses on human memory processes.[18]

Word superiority

The word superiority experiment presents a subject with a word, or a letter by itself, for a brief period of time, i.e. 40ms, and they are then asked to recall the letter that was in a particular location in the word. By theory, the

subject should be better able to correctly recall the letter when it was presented in a word than when it was presented in isolation. This experiment focuses on human speech and language.[19]

Brown-Peterson

In the Brown-Peterson experiment, participants are briefly presented with a trigram and in one particular version of the experiment, they are then given a distractor task, asking them to identify whether a sequence of words are in fact words, or non-words (due to being misspelled, etc.). After the distractor task, they are asked to recall the trigram from before the distractor task. In theory, the longer the distractor task, the harder it will be for participants to correctly recall the trigram. This experiment focuses on human short-term memory.[20]

Memory span

During the memory span experiment, each subject is presented with a sequence of stimuli of the same kind; words depicting objects, numbers, letters that sound similar, and letters that sound dissimilar. After being presented with the stimuli, the subject is asked to recall the sequence of stimuli that they were given in the exact order in which it was given. In one particular version of the experiment, if the subject recalled a list correctly, the list length was increased by one for that type of material, and vice versa if it was recalled incorrectly. The theory is that people have a memory span of about seven items for numbers, the same for letters that sound dissimilar and short words. The memory span is projected to be shorter with letters that sound similar and with longer words.[21]

Visual search

In one version of the visual search experiment, a participant is presented with a window that displays circles and squares scattered across it. The participant is to identify whether there is a green circle on the window. In the "featured" search, the subject is presented with several trial windows that have blue squares or circles and one green circle or no green circle in it at all. In the "conjunctive" search, the subject is presented with trial windows that have blue circles or green squares and a present or absent

green circle whose presence the participant is asked to identify. What is expected is that in the feature searches, reaction time, that is the time it takes for a participant to identify whether a green circle is present or not, should not change as the number of distractors increases. Conjunctive searches where the target is absent should have a longer reaction time than the conjunctive searches where the target is present. The theory is that in feature searches, it is easy to spot the target, or if it is absent, because of the difference in color between the target and the distractors. In conjunctive searches where the target is absent, reaction time increases because the subject has to look at each shape to determine whether it is the target or not because some of the distractors if not all of them, are the same color as the target stimuli. Conjunctive searches where the target is present take less time because if the target is found, the search between each shape stops.[22]

Knowledge representation

The semantic network of knowledge representation systems has been studied in various paradigms. One of the oldest paradigms is the leveling and sharpening of stories as they are repeated from memory studied by Bartlett. The semantic differential used factor analysis to determine the main meanings of words, finding that value or "goodness" of words is the first factor. More controlled experiments examine the categorical relationships of words in free recall. The hierarchical structure of words has been explicitly mapped in George Miller's Wordnet. More dynamic models of semantic networks have been created and tested with neural network experiments based on computational systems such as latent semantic analysis (LSA), Bayesian analysis, and multidimensional factor analysis. The semantics (meaning) of words is studied by all the disciplines of cognitive science.[*citation needed*]

Metacognition

This section is transcluded from Metacognition. (edit | history)

Metacognition is "cognition about cognition", " thinking about thinking", " knowing about knowing", becoming "aware of one's awareness" and higher-order thinking skills. The term comes from the root word *meta*, meaning "beyond".[23] Metacognition can take many forms; it includes knowledge about when and how to use particular strategies for learning or for problem-solving.[23] There are generally two components of metacognition: (1) knowledge about cognition and (2) regulation of cognition.[24]

Metamemory, defined as knowing about memory and mnemonic strategies, is an especially important form of metacognition.[25] Academic research on metacognitive processing across cultures is in the early stages, but there are indications that further work may provide better outcomes in cross-cultural learning between teachers and students.[26]

Some evolutionary psychologists hypothesize that humans use metacognition as a survival tool, which would make metacognition the same across cultures.[26][*need quotation to verify*] Writings on metacognition date back at least as far as two works by the Greek philosopher Aristotle (384-322 BC): *On the Soul* and the *Parva Naturalia*.[27]

See also

- Cognitive biology
- Cognitive computing
- Cognitive psychology
- Cognitive science
- Comparative cognition
- Information processing technology and aging
- Nootropic
- Outline of human intelligence – topic tree presenting the traits, capacities, models, and research fields of human intelligence, and more.
- Outline of thought – topic tree that identifies many types of thoughts, types of thinking, aspects of thought, related fields, and more.

TOC Previous Next

References

1. ^ *"cognition - definition of cognition in English from the Oxford dictionary". www.oxforddictionaries.com. Retrieved 2016-02-04.*
2. ^ *Von Eckardt, Barbara (1996). What is cognitive science?. Massachusetts: MIT Press. pp. 45–72. ISBN 9780262720236.*
3. ^ *Stefano Franchi, Francesco Bianchini. "On The Historical Dynamics Of Cognitive Science: A View From The Periphery". The Search for a Theory of Cognition: Early Mechanisms and New Ideas. Rodopi, 2011. p. XIV.*
4. ^ Cognition: Theory and Practice by Russell Revlin
5. ^ *Matlin, Margaret (2009). Cognition. Hoboken, NJ: John Wiley & Sons, Inc. p. 4.*
6. ^ ***a b*** *Fuchs, A. H.; Milar, K.J. (2003). "Psychology as a science". Handbook of psychology.* ***1*** *(The history of psychology): 1–26. doi:10.1002/0471264385.wei0101.*
7. ^ *Zangwill, O. L. (2004). The Oxford companion to the mind. New York: Oxford University Press. pp. 951–952.*
8. ^ *Zangwill, O.L. (2004). The Oxford companion to the mind. New York: Oxford University Press. p. 276.*
9. ^ T.L. Brink (2008) Psychology: A Student Friendly Approach. "Unit 7: Memory." p. 126
10. ^ *Madigan, S.; O'Hara, R. (1992). "Short-term memory at the turn of the century: Mary Whiton Calkin's memory research". American Psychologist.* ***47*** *(2): 170–174. doi:10.1037/0003-066X.47.2.170.*
11. ^ ***a b*** *Matlin, Margaret (2009). Cognition. Hoboken, NJ: John Wiley & Sons, Inc. p. 5.*
12. ^ ***a b*** Sternberg, R. J., & Sternberg, K. (2009). Cognitive psychology (6th Ed.). Belmont, CA: Wadsworth, Cengage Learning.
13. ^ *Blomberg, O. (2011). "Concepts of cognition for cognitive engineering". International Journal of Aviation Psychology.* ***21*** *(1): 85–104. doi:10.1080/10508414.2011.537561.*
14. ^ *Sensation & Perception*, 5th ed. 1999, Coren, Ward & Enns, p. 9
15. ^ *Cognitive Psychology*, 5th ed. 1999, Best, John B., pp. 15–17
16. ^ *Cherry, Kendra. "Jean Piaget Biography". The New York Times*

Company. *Retrieved 18 September 2012.*

17. ^ Parke, R. D., & Gauvain, M. (2009). Child psychology: A contemporary viewpoint (7th Ed.). Boston, MA: McGraw-Hill.
18. ^ *Surprenant, A (2001). "Distinctiveness and serial position effects in total sequences". Perception and Psychophysics.* ***63*** *(4): 737–745. doi:10.3758/BF03194434. PMID 11436742.*
19. ^ *Krueger, L. (1992). "The word-superiority effect and phonological recoding". Memory & Cognition.* ***20*** *(6): 685–694. doi:10.3758/BF03202718.*
20. ^ *Nairne, J.; Whiteman, H.; Kelley, M. (1999). "Short-term forgetting of order under conditions of reduced interference" (PDF). Quarterly Journal of Experimental Psychology A: Human Experimental Psychology.* ***52****: 241–251. doi:10.1080/713755806.*
21. ^ *May, C.; Hasher, L.; Kane, M. (1999). "The role of interference in memory span". Memory & Cognition.* ***27*** *(5): 759–767. doi:10.3758/BF03198529. PMID 10540805.*
22. ^ *Wolfe, J.; Cave, K.; Franzel, S. (1989). "Guided search: An alternative to the feature integration model for visual search". Journal of Experimental Psychology: Human Perception and Performance.* ***15*** *(3): 419–433. doi:10.1037/0096-1523.15.3.419.*
23. ^ ***a*** ***b*** Metcalfe, J., & Shimamura, A. P. (1994). *Metacognition: knowing about knowing*. Cambridge, MA: MIT Press.
24. ^ *Schraw, Gregory (1998). "Promoting general metacognitive awareness". Instructional Science.* ***26****: 113–125. doi:10.1023/A:1003044231033.*
25. ^ Dunlosky, J. & Bjork, R. A. (Eds.). *Handbook of Metamemory and Memory*. Psychology Press: New York.
26. ^ ***a*** ***b*** Wright, Frederick. APERA Conference 2008. 14 April 2009. http://www.apera08.nie.edu.sg/proceedings/4.24.pdf [*dead link*]
27. ^ *Colman, Andrew M. (2015) [2001]. "metacognition". A Dictionary of Psychology. Oxford Paperback Reference (4 ed.). Oxford: Oxford University Press. p. 456. ISBN 9780199657681. Retrieved 2017-05-17. "Writings on metacognition can be traced back at least as far as De Anima and the Parva Naturalia of the Greek philosopher Aristotle (384-322 BC) [...]."*

Further reading

- Coren, Stanley; Lawrence M. Ward; James T. Enns (1999). *Sensation and Perception*. Harcourt Brace. p. 9. ISBN 0-470-00226-3.
- Lycan, W.G., (ed.). (1999). *Mind and Cognition: An Anthology*, 2nd Edition. Malden, Mass: Blackwell Publishers, Inc.
- Stanovich, Keith (2009). *What Intelligence Tests Miss: The Psychology of Rational Thought*. New Haven (CT): Yale University Press. ISBN 978-0-300-12385-2. Lay summary (PDF) (21 November 2010).

TOC Previous

External links

- *Cognition* An international journal publishing theoretical and experimental papers on the study of the mind.
- Information on music cognition, University of Amsterdam
- Cognitie.NL Information on cognition research, Netherlands Organisation for Scientific Research (NWO) and University of Amsterdam (UvA)
- Emotional and Decision Making Lab, Carnegie Mellon, EDM Lab
- The Limits of Human Cognition – an article describing the evolution of mammals' cognitive abilities
- Half-heard phone conversations reduce cognitive performance
- The limits of intelligence Douglas Fox, *Scientific American*, 14 June 14, 2011.

Categories: Cognition | Cognitive science | Psychology

This page was last edited on 8 June 2018, at 10:10.

Back to main TOC

Contents

Perception

Jump to navigation Jump to search
"Percept", "Perceptual", "Perceptible", and "Imperceptible" redirect here. For other uses, see Perception (disambiguation) and Percept (disambiguation).

Perception (from the Latin *perceptio*) is the organization, identification, and interpretation of sensory information in order to represent and understand the presented information, or the environment.[2]

All perception involves signals that go through the nervous system, which in turn result from physical or chemical stimulation of the sensory system.[3] For example, vision involves light striking the retina of the eye, smell is mediated by odor molecules, and hearing involves pressure waves.

Perception is not only the passive receipt of these signals, but it's also shaped by the recipient's learning, memory, expectation, and attention.[4][5]

Perception can be split into two processes, [5] (1) processing the sensory input, which transforms these low-level information to higher-level information (e.g., extracts shapes for object recognition), (2) processing which is connected with a person's concepts and expectations (or knowledge), restorative and selective mechanisms (such as attention) that influence perception.

Perception depends on complex functions of the nervous system, but subjectively seems mostly effortless because this processing happens outside conscious awareness. [3]

Since the rise of experimental psychology in the 19th Century, psychology's understanding of perception has progressed by combining

a variety of techniques. [4] Psychophysics quantitatively describes the relationships between the physical qualities of the sensory input and perception.[6] Sensory neuroscience studies the neural mechanisms underlying perception. Perceptual systems can also be studied computationally, in terms of the information they process. Perceptual issues in philosophy include the extent to which sensory qualities such as sound, smell or color exist in objective reality rather than in the mind of the perceiver.[4]

Although the senses were traditionally viewed as passive receptors, the study of illusions and ambiguous images has demonstrated that the brain's perceptual systems actively and pre-consciously attempt to make sense of their input.[4] There is still active debate about the extent to which perception is an active process of hypothesis testing, analogous to science, or whether realistic sensory information is rich enough to make this process unnecessary.[4]

The perceptual systems of the brain enable individuals to see the world around them as stable, even though the sensory information is typically incomplete and rapidly varying. Human and animal brains are structured in a modular way, with different areas processing different kinds of sensory information. Some of these modules take the form of sensory maps, mapping some aspect of the world across part of the brain's surface. These different modules are interconnected and influence each other. For instance, taste is strongly influenced by smell.[7]

Process and terminology

The process of perception begins with an object in the real world, termed the *distal stimulus* or *distal object*.[3] By means of light, sound or another physical process, the object stimulates the body's sensory organs. These sensory organs transform the input energy into neural activity—a process called *transduction*.[3][8] This raw pattern of neural activity is called the *proximal stimulus*.[3] These neural signals are transmitted to the brain and processed.[3] The resulting mental re-creation of the distal stimulus is the *percept*.

An example would be a shoe. The shoe itself is the distal stimulus. When light from the shoe enters a person's eye and stimulates the retina, that stimulation is the proximal stimulus.[9] The image of the shoe reconstructed by the brain of the person is the percept. Another example would be a telephone ringing. The ringing of the telephone is the distal stimulus. The sound stimulating a person's auditory receptors is the proximal stimulus, and the brain's interpretation of this as the ringing of a telephone is the percept. The different kinds of sensation such as warmth, sound, and taste are called *sensory modalities* multi.[8][10]

Psychologist Jerome Bruner has developed a model of perception. According to him, people go through the following process to form opinions:[11]

1. When we encounter an unfamiliar target, we are open to different informational cues and want to learn more about the target.
2. In the second step, we try to collect more information about the target. Gradually, we encounter some familiar cues which help us categorize the target.
3. At this stage, the cues become less open and selective. We try to search for more cues that confirm the categorization of the target. We also actively ignore and even distort cues that violate our initial perceptions. Our perception becomes more selective and we finally paint a consistent picture of the target.

According to Alan Saks and Gary Johns, there are three components to perception.[11]

1. The Perceiver, the person who becomes aware about something and comes to a final understanding. There are 3 factors that can influence his or her perceptions: experience, motivational state and finally emotional state. In different motivational or emotional states, the perceiver will react to or perceive something in different ways. Also in different situations he or she might employ a "perceptual defence" where they tend to "see what they want to see".
2. The Target. This is the person who is being perceived or judged. "Ambiguity or lack of information about a target leads to a greater need for interpretation and addition."
3. The Situation also greatly influences perceptions because different situations may call for additional information about the target.

Stimuli are not necessarily translated into a percept and rarely does a single stimulus translate into a percept. An ambiguous stimulus may be translated into multiple percepts, experienced randomly, one at a time, in what is called *multistable perception*. And the same stimuli, or absence of them, may result in different percepts depending on subject's culture and previous experiences. Ambiguous figures demonstrate that a single stimulus can result in more than one percept; for example the Rubin vase which can be interpreted either as a vase or as two faces. The percept can bind sensations from multiple senses into a whole. A picture of a talking person on a television screen, for example, is bound to the sound of speech from speakers to form a percept of a talking person. "**Percept**" is also a term used by Leibniz,[12] Bergson, Deleuze, and Guattari[13] to define perception independent from perceivers.

Reality

In the case of visual perception, some people can actually see the percept shift in their mind's eye.[14] Others, who are not picture thinkers, may not necessarily perceive the 'shape-shifting' as their world changes. The 'esemplastic' nature has been shown by experiment: an ambiguous image has multiple interpretations on the perceptual level.

This confusing ambiguity of perception is exploited in human technologies such as camouflage, and also in biological mimicry, for example by European peacock butterflies, whose wings bear eyespots that birds respond to as though they were the eyes of a dangerous predator.

There is also evidence that the brain in some ways operates on a slight "delay", to allow nerve impulses from distant parts of the body to be integrated into simultaneous signals.[15]

Perception is one of the oldest fields in psychology. The oldest quantitative laws in psychology are Weber's law – which states that the smallest noticeable difference in stimulus intensity is proportional to the intensity of the reference – and Fechner's law which quantifies the relationship between the intensity of the physical stimulus and its perceptual counterpart (for example, testing how much darker a computer screen can get before the viewer actually notices). The study of perception gave rise to the Gestalt school of psychology, with its emphasis on holistic approach.

Features

Constancy

Main article: Subjective constancy

Perceptual constancy is the ability of perceptual systems to recognize the same object from widely varying sensory inputs.[5]:118–120[16] For example, individual people can be recognized from views, such as frontal and profile, which form very different shapes on the retina. A coin looked at face-on makes a circular image on the retina, but when held at angle it makes an elliptical image.[17] In normal perception these are recognized as a single three-dimensional object. Without this correction process, an animal approaching from the distance would appear to gain in size.[18][19] One kind of perceptual constancy is *color constancy*: for example, a white piece of paper can be recognized as such under different colors and intensities of light.[19] Another example is *roughness constancy*: when a hand is drawn quickly across a surface, the touch nerves are stimulated more intensely. The brain compensates for this, so the speed of contact does not affect the perceived roughness.[19] Other constancies include melody, odor, brightness and words.[20] These constancies are not always total, but the variation in the percept is much less than the variation in the physical stimulus.[19] The perceptual systems of the brain achieve perceptual constancy in a variety of ways, each specialized for the kind of information being processed[21], with phonemic restoration as a notable example from hearing.

Grouping

Main article: Principles of grouping

The *principles of grouping* (or *Gestalt laws of grouping*) are a set of

principles in psychology, first proposed by Gestalt psychologists to explain how humans naturally perceive objects as organized patterns and objects. Gestalt psychologists argued that these principles exist because the mind has an innate disposition to perceive patterns in the stimulus based on certain rules. These principles are organized into six categories: *proximity*, *similarity*, *closure*, *good continuation*, *common fate* and *good form*.

The principle of *proximity* states that, all else being equal, perception tends to group stimuli that are close together as part of the same object, and stimuli that are far apart as two separate objects. The principle of *similarity* states that, all else being equal, perception lends itself to seeing stimuli that physically resemble each other as part of the same object, and stimuli that are different as part of a different object. This allows for people to distinguish between adjacent and overlapping objects based on their visual texture and resemblance. The principle of *closure* refers to the mind's tendency to see complete figures or forms even if a picture is incomplete, partially hidden by other objects, or if part of the information needed to make a complete picture in our minds is missing. For example, if part of a shape's border is missing people still tend to see the shape as completely enclosed by the border and ignore the gaps. The principle of *good continuation* makes sense of stimuli that overlap: when there is an intersection between two or more objects, people tend to perceive each as a single uninterrupted object. The principle of *common fate* groups stimuli together on the basis of their movement. When visual elements are seen moving in the same direction at the same rate, perception associates the movement as part of the same stimulus. This allows people to make out moving objects even when other details, such as color or outline, are obscured. The principle of *good form* refers to the tendency to group together forms of similar shape, pattern, color, etc.[22][23][24][25] Later research has identified additional grouping principles.[26]

TOC Previous Next

Contrast effects

Main article: Contrast effect

A common finding across many different kinds of perception is that the perceived qualities of an object can be affected by the qualities of context. If one object is extreme on some dimension, then neighboring objects are perceived as further away from that extreme. "Simultaneous contrast effect" is the term used when stimuli are presented at the same time, whereas "successive contrast" applies when stimuli are presented one after another.[27]

The contrast effect was noted by the 17th Century philosopher John Locke, who observed that lukewarm water can feel hot or cold, depending on whether the hand touching it was previously in hot or cold water.[28] In the early 20th Century, Wilhelm Wundt identified contrast as a fundamental principle of perception, and since then the effect has been confirmed in many different areas.[28] These effects shape not only visual qualities like color and brightness, but other kinds of perception, including how heavy an object feels.[29] One experiment found that thinking of the name "Hitler" led to subjects rating a person as more hostile.[30] Whether a piece of music is perceived as good or bad can depend on whether the music heard before it was pleasant or unpleasant.[31] For the effect to work, the objects being compared need to be similar to each other: a television reporter can seem smaller when interviewing a tall basketball player, but not when standing next to a tall building.[29] In the brain, brightness contrast exerts effects on both neuronal firing rates and neuronal synchrony.[32]

Effect of experience

Main article: Perceptual learning

With experience, organisms can learn to make finer perceptual distinctions, and learn new kinds of categorization. Wine-tasting, the reading of X-ray images and music appreciation are applications of this process in the human sphere. Research has focused on the relation of this to other kinds of learning, and whether it takes place in peripheral sensory systems or in the brain's processing of sense information.[33] Empirical research show that specific practices (such as yoga, mindfulness, Tai Chi, meditation, Daoshi and other mind-body disciplines) can modify human perceptual modality. Specifically, these practices enable perception skills to switch from the external (exteroceptive field) towards a higher ability to focus on internal signals (proprioception). Also, when asked to provide verticality judgments, highly self-transcendent yoga practitioners were significantly less influenced by a misleading visual context. Increasing self-transcendence may enable yoga practitioners to optimize verticality judgment tasks by relying more on internal (vestibular and proprioceptive) signals coming from their own body, rather than on exteroceptive, visual cues.[34]

Effect of motivation and expectation

Main article: Set (psychology)

A *perceptual set*, also called *perceptual expectancy* or just *set* is a predisposition to perceive things in a certain way.[35] It is an example of how perception can be shaped by "top-down" processes such as drives and expectations.[36] Perceptual sets occur in all the different senses.[18] They can be long term, such as a special sensitivity to hearing one's own name in a crowded room, or short term, as in the ease with which hungry people notice the smell of food.[37] A simple demonstration of the effect involved very brief presentations of non-words such as "sael". Subjects who were told to expect words about animals read it as "seal", but others who were expecting boat-related words read it as "sail".[37]

Sets can be created by motivation and so can result in people interpreting ambiguous figures so that they see what they want to see.[36] For instance, how someone perceives what unfolds during a sports game can be biased if they strongly support one of the teams.[38] In one experiment, students were allocated to pleasant or unpleasant tasks by a computer. They were told that either a number or a letter would flash on the screen to say whether they were going to taste an orange juice drink or an unpleasant-tasting health drink. In fact, an ambiguous figure was flashed on screen, which could either be read as the letter B or the number 13. When the letters were associated with the pleasant task, subjects were more likely to perceive a letter B, and when letters were associated with the unpleasant task they tended to perceive a number 13.[35]

Perceptual set has been demonstrated in many social contexts. People who are primed to think of someone as "warm" are more likely to perceive a variety of positive characteristics in them, than if the word "warm" is replaced by "cold". When someone has a reputation for being funny, an audience is more likely to find them amusing.[37] Individual's perceptual sets reflect their own personality traits. For example, people with an aggressive personality are quicker to correctly identify aggressive words or

situations.[37]

One classic psychological experiment showed slower reaction times and less accurate answers when a deck of playing cards reversed the color of the suit symbol for some cards (e.g. red spades and black hearts).[39]

Philosopher Andy Clark explains that perception, although it occurs quickly, is not simply a bottom-up process (where minute details are put together to form larger wholes). Instead, our brains use what he calls 'predictive coding'. It starts with very broad constraints and expectations for the state of the world, and as expectations are met, it makes more detailed predictions (errors lead to new predictions, or learning processes). Clark says this research has various implications; not only can there be no completely "unbiased, unfiltered" perception, but this means that there is a great deal of feedback between perception and expectation (perceptual experiences often shape our beliefs, but those perceptions were based on existing beliefs)[40]. Indeed, predictive coding provides an account where this type of feedback assists in stabilizing our inference-making process about the physical world, such as with perceptual constancy examples.

Theories

TOC Previous Next

Perception as direct perception

Cognitive theories of perception assume there is a poverty of stimulus. This (with reference to perception) is the claim that sensations are, by themselves, unable to provide a unique description of the world.[41] Sensations require 'enriching', which is the role of the mental model. A different type of theory is the perceptual ecology approach of James J. Gibson. Gibson rejected the assumption of a poverty of stimulus by rejecting the notion that perception is based upon sensations – instead, he investigated what information is actually presented to the perceptual systems. His theory "assumes the existence of stable, unbounded, and permanent stimulus-information in the ambient optic array. And it supposes that the visual system can explore and detect this information. The theory is information-based, not sensation-based."[42] He and the psychologists who work within this paradigm detailed how the world could be specified to a mobile, exploring organism via the lawful projection of information about the world into energy arrays.[43] "Specification" would be a 1:1 mapping of some aspect of the world into a perceptual array; given such a mapping, no enrichment is required and perception is direct perception.[44]

TOC Previous Next

Perception-in-action

An ecological understanding of perception derived from Gibson's early work is that of "perception-in-action", the notion that perception is a requisite property of animate action; that without perception, action would be unguided, and without action, perception would serve no purpose. Animate actions require both perception and motion, and perception and movement can be described as "two sides of the same coin, the coin is action". Gibson works from the assumption that singular entities, which he

calls "invariants", already exist in the real world and that all that the perception process does is to home in upon them. A view known as constructivism (held by such philosophers as Ernst von Glasersfeld) regards the continual adjustment of perception and action to the external input as precisely what constitutes the "entity", which is therefore far from being invariant.[45]

Glasersfeld considers an "invariant" as a target to be homed in upon, and a pragmatic necessity to allow an initial measure of understanding to be established prior to the updating that a statement aims to achieve. The invariant does not and need not represent an actuality, and Glasersfeld describes it as extremely unlikely that what is desired or feared by an organism will never suffer change as time goes on. This social constructionist theory thus allows for a needful evolutionary adjustment.[46]

A mathematical theory of perception-in-action has been devised and investigated in many forms of controlled movement, and has been described in many different species of organism using the General Tau Theory. According to this theory, tau information, or time-to-goal information is the fundamental 'percept' in perception.

Evolutionary psychology (EP) and perception

Many philosophers, such as Jerry Fodor, write that the purpose of perception is knowledge, but evolutionary psychologists hold that its primary purpose is to guide action.[47] For example, they say, depth perception seems to have evolved not to help us know the distances to other objects but rather to help us move around in space.[47] Evolutionary psychologists say that animals from fiddler crabs to humans use eyesight for collision avoidance, suggesting that vision is basically for directing action, not providing knowledge.[47]

Building and maintaining sense organs is metabolically expensive, so these organs evolve only when they improve an organism's fitness.[47] More than

half the brain is devoted to processing sensory information, and the brain itself consumes roughly one-fourth of one's metabolic resources, so the senses must provide exceptional benefits to fitness.[47] Perception accurately mirrors the world; animals get useful, accurate information through their senses.[47]

Scientists who study perception and sensation have long understood the human senses as adaptations.[47] Depth perception consists of processing over half a dozen visual cues, each of which is based on a regularity of the physical world.[47] Vision evolved to respond to the narrow range of electromagnetic energy that is plentiful and that does not pass through objects.[47] Sound waves provide useful information about the sources of and distances to objects, with larger animals making and hearing lower-frequency sounds and smaller animals making and hearing higher-frequency sounds.[47] Taste and smell respond to chemicals in the environment that were significant for fitness in the environment of evolutionary adaptedness.[47] The sense of touch is actually many senses, including pressure, heat, cold, tickle, and pain.[47] Pain, while unpleasant, is adaptive.[47] An important adaptation for senses is range shifting, by which the organism becomes temporarily more or less sensitive to sensation.[47] For example, one's eyes automatically adjust to dim or bright ambient light.[47] Sensory abilities of different organisms often coevolve, as is the case with the hearing of echolocating bats and that of the moths that have evolved to respond to the sounds that the bats make.[47]

Evolutionary psychologists claim that perception demonstrates the principle of modularity, with specialized mechanisms handling particular perception tasks.[47] For example, people with damage to a particular part of the brain suffer from the specific defect of not being able to recognize faces (prospagnosia).[47] EP suggests that this indicates a so-called face-reading module.[47]

TOC | Previous | Next

Theories of perception

- Empirical theories of perception

- Enactivism
- Anne Treisman's feature integration theory
- Interactive activation and competition
- Irving Biederman's recognition by components theory

TOC | Previous | Next

Physiology

Main article: Sensory system

A *sensory system* is a part of the nervous system responsible for processing sensory information. A sensory system consists of sensory receptors, neural pathways, and parts of the brain involved in sensory perception. Commonly recognized sensory systems are those for vision, hearing, somatic sensation (touch), taste and olfaction (smell). It has been suggested that the immune system is an overlooked sensory modality.[48] In short, senses are transducers from the physical world to the realm of the mind.

The receptive field is the specific part of the world to which a receptor organ and receptor cells respond. For instance, the part of the world an eye can see, is its receptive field; the light that each rod or cone can see, is its receptive field.[49] Receptive fields have been identified for the visual system, auditory system and somatosensory system, so far. Research attention is currently focused not only on external perception processes, but also to "Interoception", considered as the process of receiving, accessing and appraising internal bodily signals. Maintaining desired physiological states is critical for an organism’s well being and survival. Interoception is an iterative process, requiring the interplay between perception of body states and awareness of these states to generate proper self-regulation. Afferent sensory signals continuously interact with higher order cognitive representations of goals, history, and environment, shaping emotional experience and motivating regulatory behavior.[50]

Types

Vision

Main article: Visual perception

In many ways, vision is the primary human sense. Light is taken in through each eye and focused in a way which sorts it on the retina according to direction of origin. A dense surface of photosensitive cells, including rods, cones, and intrinsically photosensitive retinal ganglion cells captures information about the intensity, color, and position of incoming light. Some processing of texture and movement occurs within the neurons on the retina before the information is sent to the brain. In total, about 15 differing types of information are then forwarded to the brain proper via the optic nerve.[51]

Sound

Main article: Hearing (sense)

Hearing (or *audition*) is the ability to perceive sound by detecting vibrations. Frequencies capable of being heard by humans are called audio or *sonic*. The range is typically considered to be between 20 Hz and 20,000 Hz.[52] Frequencies higher than audio are referred to as ultrasonic, while frequencies below audio are referred to as infrasonic. The auditory system includes the outer ears which collect and filter sound waves, the middle ear for transforming the sound pressure (impedance matching), and the inner ear which produces neural signals in response to the sound. By the ascending auditory pathway these are led to the primary auditory cortex within the temporal lobe of the human brain, which is where the auditory information arrives in the cerebral cortex and is further processed there.

Sound does not usually come from a single source: in real situations, sounds from multiple sources and directions are superimposed as they arrive at the ears. Hearing involves the computationally complex task of separating out the sources of interest, often estimating their distance and direction as well as identifying them.[17]

Touch

Main article: Haptic perception

Haptic perception is the process of recognizing objects through touch. It involves a combination of somatosensory perception of patterns on the skin surface (e.g., edges, curvature, and texture) and

proprioception of hand position and conformation. People can rapidly and accurately identify three-dimensional objects by touch.[53] This involves exploratory procedures, such as moving the fingers over the outer surface of the object or holding the entire object in the hand.[54] Haptic perception relies on the forces experienced during touch.[55]

Gibson defined the haptic system as "The sensibility of the individual to the world adjacent to his body by use of his body".[56] Gibson and others emphasized the close link between haptic perception and body movement: haptic perception is active exploration. The concept of haptic perception is related to the concept of extended physiological proprioception according to which, when using a tool such as a stick, perceptual experience is transparently transferred to the end of the tool.

☰ TOC | ← Previous | Next →

Taste

Main article: Taste

Taste (or, the more formal term, *gustation*) is the ability to perceive the flavor of substances including, but not limited to, food. Humans receive tastes through sensory organs called *taste buds*, or *gustatory calyculi*, concentrated on the upper surface of the tongue.[57] The human tongue has 100 to 150 taste receptor cells on each of its roughly ten thousand taste buds.[58] There are five primary tastes: sweetness, bitterness, sourness, saltiness, and umami. Other tastes can be mimicked by combining these basic tastes.[58][59] The recognition and awareness of umami is a relatively recent development in Western cuisine.[60][61] The basic tastes contribute only partially to the sensation and flavor of food in the mouth — other factors include smell, detected by the olfactory epithelium of the nose;[7] texture, detected through a variety of mechanoreceptors, muscle nerves, etc.;[59][62] and temperature, detected by thermoreceptors.[59] All basic tastes are classified as either *appetitive* or *aversive*, depending upon whether the things they sense are harmful or beneficial.[63]

☰ TOC | ← Previous | Next →

Smell

☰ TOC | ← Previous | Next →

Social

Main article: Social perception

Social perception is the part of perception that allows people to understand the individuals and groups of their social world, and thus an element of social cognition.[64]

☰ TOC | ← Previous | Next →

Speech

Main article: Speech perception

Speech perception is the process by which spoken languages are heard, interpreted and understood. Research in speech perception seeks to understand how human listeners recognize speech sounds and use this information to understand spoken language. The sound of a word can vary widely according to words around it and the tempo of the speech, as well as the physical characteristics, accent and mood of the speaker. Listeners manage to perceive words across this wide range of different conditions. Another variation is that reverberation can make a large difference in sound between a word spoken from the far side of a room and the same word spoken up close. Experiments have shown that people automatically compensate for this effect when hearing speech.[17][65]

The process of perceiving speech begins at the level of the sound within the auditory signal and the process of audition. The initial auditory signal is compared with visual information — primarily lip movement — to extract acoustic cues and phonetic information. It is possible other sensory modalities are integrated at this stage as well.[66] This speech information can then be used for higher-level language processes, such as word recognition.

Speech perception is not necessarily uni-directional. That is, higher-level language processes connected with morphology, syntax, or semantics may interact with basic speech perception processes to aid in recognition of speech sounds.[*citation needed*] It may be the case that it is not necessary and maybe even not possible for a listener to recognize phonemes before recognizing higher units, like words for example. In one experiment, Richard M. Warren replaced one phoneme of a word with a cough-like sound. His subjects restored the missing speech sound perceptually without any difficulty and what is more, they were not able to identify accurately which phoneme had been disturbed.[67]

☰ TOC | ← Previous | Next →

Faces

Main article: Face perception

Facial perception refers to cognitive processes specialized for handling human faces, including perceiving the identity of an individual, and facial expressions such as emotional cues.

☰ TOC | ← Previous | Next →

Social touch

Main article: Somatosensory system § Neural processing of social touch

The somatosensory cortex encodes incoming sensory information from receptors all over the body. Affective touch is a type of sensory information that elicits an emotional reaction and is usually social

in nature, such as a physical human touch. This type of information is actually coded differently than other sensory information. Intensity of affective touch is still encoded in the primary somatosensory cortex, but the feeling of pleasantness associated with affective touch activates the anterior cingulate cortex more than the primary somatosensory cortex. Functional magnetic resonance imaging (fMRI) data shows that increased blood oxygen level contrast (BOLD) signal in the anterior cingulate cortex as well as the prefrontal cortex is highly correlated with pleasantness scores of an affective touch. Inhibitory transcranial magnetic stimulation (TMS) of the primary somatosensory cortex inhibits the perception of affective touch intensity, but not affective touch pleasantness. Therefore, the S1 is not directly involved in processing socially affective touch pleasantness, but still plays a role in discriminating touch location and intensity.[68]

TOC ← Previous Next →

Other senses

Main article: Sense

Other senses enable perception of body balance, acceleration, gravity, position of body parts, temperature, pain, time, and perception of internal senses such as suffocation, gag reflex, intestinal distension, fullness of rectum and urinary bladder, and sensations felt in the throat and lungs.

TOC ← Previous Next →

See also

- Action-specific perception
- Alice in Wonderland syndrome
- Apophenia
- Change blindness
- Ideasthesia
- Introspection
- Model-dependent realism
- Multisensory integration
- Near sets
- Neural correlates of consciousness
- Pareidolia
- Perceptual paradox
- Philosophy of perception
- Proprioception
- Qualia
- Recept
- Samjñā, the Buddhist concept of perception
- Simulated reality
- Simulation
- Visual routine
- Transsaccadic memory

TOC | Previous | Next

Notes

1. ^ "Soltani, A. A., Huang, H., Wu, J., Kulkarni, T. D., & Tenenbaum, J. B. Synthesizing 3D Shapes via Modeling Multi-View Depth Maps and Silhouettes With Deep Generative Networks. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 1511-1519)." Archived from the original on 9 May 2018.
2. ^ Schacter, Daniel (2011). *Psychology*. Worth Publishers.
3. ^ *a b c d e f* Goldstein (2009) pp. 5–7
4. ^ *a b c d e* Gregory, Richard. "Perception" in Gregory, Zangwill (1987) pp. 598–601.
5. ^ *a b c* Bernstein, Douglas A. (5 March 2010). *Essentials of Psychology*. Cengage Learning. pp. 123–124. ISBN 978-0-495-90693-3. Archived from the original on 2 January 2017. Retrieved 25 March 2011.
6. ^ Gustav Theodor Fechner. Elemente der Psychophysik. Leipzig 1860
7. ^ *a b* DeVere, Ronald; Calvert, Marjorie (31 August 2010). *Navigating Smell and Taste Disorders*. Demos Medical Publishing. pp. 33–37. ISBN 978-1-932603-96-5. Archived from the original on 9 November 2011. Retrieved 26 March 2011.
8. ^ *a b* Pomerantz, James R. (2003): "Perception: Overview". In: Lynn Nadel (Ed.), *Encyclopedia of Cognitive Science*, Vol. 3, London: Nature Publishing Group, pp. 527–537
9. ^ "Sensation and Perception". Archived from the original on 10 May 2011.
10. ^ Willis, William D.; Coggeshall, Richard E. (31 January 2004). *Sensory Mechanisms of the Spinal Cord: Primary afferent neurons and the spinal dorsal horn*. Springer. p. 1. ISBN 978-0-306-48033-1. Archived from the original on 9 November 2011. Retrieved 25 March 2011.
11. ^ *a b* Alan S. & Gary J. (2011). Perception, Attribution, and Judgment of Others. Organizational Behaviour: Understanding and Managing Life at Work Vol. 7
12. ^ Leibniz' *Monadology*
13. ^ Deleuze and Guattari's *What is Philosophy?*
14. ^ Wettlaufer, Alexandra K. (2003). *In the mind's eye : the visual impulse in Diderot, Baudelaire and Ruskin, pg. 257*. Amsterdam: Rodopi. ISBN 90-420-1035-5.
15. ^ The Secret Advantage Of Being Short Archived 21 May 2009 at the Wayback Machine. by Robert Krulwich. *All Things Considered*, NPR. 18 May 2009.
16. ^ Atkinson, Rita L.; Atkinson, Richard C.; Smith, Edward E. (March 1990). *Introduction to psychology*. Harcourt Brace Jovanovich. pp. 177–183. ISBN 978-0-15-543689-3. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
17. ^ *a b c* Moore, Brian C. J. (15 October 2009). "Audition". In Goldstein, E. Bruce. *Encyclopedia*

of Perception. Sage. pp. 136–137. ISBN 978-1-4129-4081-8. Archived from the original on 9 November 2011. Retrieved 26 March 2011.

18. ^ *a* *b* Sonderegger, Theo (16 October 1998). *Psychology*. John Wiley and Sons. pp. 43–46. ISBN 978-0-8220-5327-9. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
19. ^ *a* *b* *c* *d* Goldstein, E. Bruce (15 October 2009). "Constancy". In Goldstein, E. Bruce. *Encyclopedia of Perception*. Sage. pp. 309–313. ISBN 978-1-4129-4081-8. Archived from the original on 9 November 2011. Retrieved 26 March 2011.
20. ^ Roeckelein, Jon E. (2006). *Elsevier's dictionary of psychological theories*. Elsevier. p. 126. ISBN 978-0-444-51750-0. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
21. ^ Yantis, Steven (2001). *Visual perception: essential readings*. Psychology Press. p. 7. ISBN 978-0-86377-598-7. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
22. ^ Gray, Peter O. (2006): *Psychology*, 5th ed., New York: Worth, p. 281. ISBN 978-0-7167-0617-5
23. ^ Wolfe, Jeremy M.; Kluender, Keith R.; Levi, Dennis M.; Bartoshuk, Linda M.; Herz, Rachel S.; Klatzky, Roberta L.; Lederman, Susan J. (2008). "Gestalt Grouping Principles". *Sensation and Perception* (2nd ed.). Sinauer Associates. pp. 78, 80. ISBN 978-0-87893-938-1. Archived from the original on 23 July 2011.
24. ^ Goldstein (2009). pp. 105–107
25. ^ Banerjee, J. C. (1994). "Gestalt Theory of Perception". *Encyclopaedic Dictionary of Psychological Terms*. M.D. Publications Pvt. Ltd. pp. 107–108. ISBN 978-81-85880-28-0.
26. ^ Weiten, Wayne (1998). *Psychology: themes and variations* (4th ed.). Brooks/Cole Pub. Co. p. 144. ISBN 978-0-534-34014-8.
27. ^ Corsini, Raymond J. (2002). *The dictionary of psychology*. Psychology Press. p. 219. ISBN 978-1-58391-328-4. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
28. ^ *a* *b* Kushner, Laura H. (2008). *Contrast in judgments of mental health*. ProQuest. p. 1. ISBN 978-0-549-91314-6. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
29. ^ *a* *b* Plous, Scott (1993). *The psychology of judgment and decision making*. McGraw-Hill. pp. 38–41. ISBN 978-0-07-050477-6. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
30. ^ Moskowitz, Gordon B. (2005). *Social cognition: understanding self and others*. Guilford

Press. p. 421. ISBN 978-1-59385-085-2. Archived from the original on 9 November 2011. Retrieved 24 March 2011.

31. ^ Popper, Arthur N. (30 November 2010). *Music Perception*. Springer. p. 150. ISBN 978-1-4419-6113-6. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
32. ^ Biederlack, J.; Castelo-Branco, M.; Neuenschwander, S.; Wheeler, D.W.; Singer, W.; Nikolić, D. (2006). "Brightness induction: Rate enhancement and neuronal synchronization as complementary codes". *Neuron*. **52**: 1073–1083. doi:10.1016/j.neuron.2006.11.012. PMID 17178409.
33. ^ Sumner, Meghan. *The Effect of Experience on the Perception and Representation of Dialect Variants* (PDF). *Journal of Memory and Language*. Elsevier Inc., 2009. Archived (PDF) from the original on 2 February 2016. Retrieved 3 June 2015.
34. ^ Fiori, Francesca; David, Nicole; Aglioti, Salvatore Maria (2014). "Processing of proprioceptive and vestibular body signals and self-transcendence in Ashtanga yoga practitioners". *Frontiers in Human Neuroscience*. **8**. doi:10.3389/fnhum.2014.00734.
35. ^ ***a b*** Weiten, Wayne (17 December 2008). *Psychology: Themes and Variations*. Cengage Learning. p. 193. ISBN 978-0-495-60197-5. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
36. ^ ***a b*** Coon, Dennis; Mitterer, John O. (29 December 2008). *Introduction to Psychology: Gateways to Mind and Behavior*. Cengage Learning. pp. 171–172. ISBN 978-0-495-59911-1. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
37. ^ ***a b c d*** Hardy, Malcolm; Heyes, Steve (2 December 1999). *Beginning Psychology*. Oxford University Press. pp. 24–27. ISBN 978-0-19-832821-6. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
38. ^ Block, J. R.; Yuker, Harold E. (1 October 2002). *Can You Believe Your Eyes?: Over 250 Illusions and Other Visual Oddities*. Robson. pp. 173–174. ISBN 978-1-86105-586-6. Archived from the original on 9 November 2011. Retrieved 24 March 2011.
39. ^ "On the Perception of Incongruity: A Paradigm" by Jerome S. Bruner and Leo Postman. *Journal of Personality*, 18, pp. 206-223. 1949. Yorku.ca Archived 15 February 2006 at the Wayback Machine.
40. ^ "Predictive Coding". Archived from the original on 5 December 2013.
41. ^ Stone, James V. (2012): "Vision and Brain: How we perceive the world", Cambridge, MIT Press, pp. 155-178.
42. ^ Gibson, James J. (2002): "A Theory of Direct Visual Perception". In: Alva Noë/Evan Thompson (Eds.), *Vision and Mind. Selected Readings in the Philosophy of Perception*, Cambridge, MIT Press, pp. 77–89.

43. ^ Sokolowski, Robert (2008). *Phenomenology of the Human Person*. New York: Cambridge University Press. pp. 199–200. ISBN 978-0521717663. Archived from the original on 25 September 2015.
44. ^ Richards, Robert J. (December 1976). "James Gibson's Passive Theory of Perception: A Rejection of the Doctrine of Specific Nerve Energies" (PDF). *Philosophy and Phenomenological Research*. **37** (2): 218–233. doi:10.2307/2107193. Archived (PDF) from the original on 13 June 2013.
45. ^ Consciousness in Action, S. L. Hurley, illustrated, Harvard University Press, 2002, 0674007964, pp. 430–432.
46. ^ Glasersfeld, Ernst von (1995), *Radical Constructivism: A Way of Knowing and Learning*, London: RoutledgeFalmer; Poerksen, Bernhard (ed.) (2004), *The Certainty of Uncertainty: Dialogues Introducing Constructivism*, Exeter: Imprint Academic; Wright. Edmond (2005). *Narrative, Perception, Language, and Faith*, Basingstoke: Palgrave Macmillan.
47. ^ ***a b c d e f g h i j k l m n o p q r s*** Gaulin, Steven J. C. and Donald H. McBurney. Evolutionary Psychology. Prentice Hall. 2003. ISBN 978-0-13-111529-3, Chapter 4, pp. 81–101.
48. ^ Bedford, F. L. (2011). "The missing sensory modality: the immune system". *Perception*. **40**: 1265–1267. doi:10.1068/p7119.
49. ^ Kolb & Whishaw: *Fundamentals of Human Neuropsychology* (2003)
50. ^ Farb N.; Daubenmier J.; Price C. J.; Gard T.; Kerr C.; Dunn B. D.; Mehling W. E. (2015). "Interoception, contemplative practice, and health". *Frontiers in Psychology*. **6**: 763. doi:10.3389/fpsyg.2015.00763.
51. ^ Gollisch, Tim; Meister, Markus (28 January 2010). "Eye Smarter than Scientists Believed: Neural Computations in Circuits of the Retina". *Neuron*. **65** (2): 150–164. doi:10.1016/j.neuron.2009.12.009.
52. ^ "Frequency Range of Human Hearing". *The Physics Factbook*. Archived from the original on 21 September 2009.
53. ^ Klatzky, R. L.; Lederman, S. J.; Metzger, V. A. (1985). "Identifying objects by touch: An "expert system." ". *Perception & Psychophysics*. **37** (4): 299–302. doi:10.3758/BF03211351.
54. ^ Lederman, S. J.; Klatzky, R. L. (1987). "Hand movements: A window into haptic object recognition". *Cognitive Psychology*. **19** (3): 342–368. doi:10.1016/0010-0285(87)90008-9. PMID 3608405.
55. ^ Robles-de-la-torre, Gabriel; Hayward, Vincent (2001). "Force can overcome object geometry in the perception of shape through active touch". *Nature*. **412** (6845): 445–448. doi:10.1038/35086588. PMID 11473320.
56. ^ Gibson, J.J. (1966). *The senses considered as perceptual systems*. Boston: Houghton Mifflin.

ISBN 0-313-23961-4.

57. ^ Human biology (Page 201/464) Archived 2 January 2017 at the Wayback Machine. Daniel D. Chiras. Jones & Bartlett Learning, 2005.
58. ^ *a* *b* DeVere, Ronald; Calvert, Marjorie (31 August 2010). *Navigating Smell and Taste Disorders*. Demos Medical Publishing. pp. 39–40. ISBN 978-1-932603-96-5. Archived from the original on 9 November 2011. Retrieved 26 March 2011.
59. ^ *a* *b* *c* Siegel, George J.; Albers, R. Wayne (2006). *Basic neurochemistry: molecular, cellular, and medical aspects*. Academic Press. p. 825. ISBN 978-0-12-088397-4. Archived from the original on 9 November 2011. Retrieved 26 March 2011.
60. ^ "Umami Dearest: The mysterious fifth taste has officially infiltrated the food scene". trendcentral.com. 23 February 2010. Archived from the original on 18 April 2011.
61. ^ "#8 Food Trend for 2010: I Want My Umami". foodchannel.com. 6 December 2009. Archived from the original on 11 July 2011.
62. ^ Food texture: measurement and perception (page 3–4/311) Archived 2 January 2017 at the Wayback Machine. Andrew J. Rosenthal. Springer, 1999.
63. ^ Why do two great tastes sometimes not taste great together? Archived 28 November 2011 at the Wayback Machine. scientificamerican.com. Dr. Tim Jacob, Cardiff University. 22 May 2009.
64. ^ E. R. Smith, D. M. Mackie (2000). *Social Psychology*. Psychology Press, 2nd ed., p. 20
65. ^ Watkins, Anthony J.; Raimond, Andrew; Makin, Simon J. (23 March 2010). "Room reflection and constancy in speech-like sounds: Within-band effects". In Lopez-Poveda, Enrique A. *The Neurophysiological Bases of Auditory Perception*. Springer. p. 440. ISBN 978-1-4419-5685-9. Archived from the original on 9 November 2011. Retrieved 26 March 2011.
66. ^ Rosenblum, Lawrence D. "Primacy of Multimodal Speech Perception". In Pisoni, David; Remez, Robert. *The Handbook of Speech Perception*. p. 51.
67. ^ Warren, R. M. (1970). "Restoration of missing speech sounds". *Science*. **167** (3917): 392–393. doi:10.1126/science.167.3917.392. PMID 5409744.
68. ^ Case, LK; Laubacher, CM; Olausson, H; Wang, B; Spagnolo, PA; Bushnell, MC. "Encoding of Touch Intensity But Not Pleasantness in Human Primary Somatosensory Cortex". *J Neurosci*. **36**: 5850–60. doi:10.1523/JNEUROSCI.1130-15.2016. PMC 4879201 . PMID 27225773.

References

- Goldstein, E. Bruce (13 February 2009a). *Sensation and Perception*. Cengage Learning. ISBN 978-0-495-60149-4. Retrieved 26 March 2011.
- Gregory, Richard L.; Zangwill, O. L. (1987). *The Oxford Companion to the Mind*. Oxford University Press. Retrieved 24 March 2011.

Bibliography

- Arnheim, R. (1969). *Visual Thinking*. Berkeley: University of California Press. ISBN 978-0-520-24226-5.
- Flanagan, J. R., & Lederman, S. J. (2001). "'Neurobiology: Feeling bumps and holes. News and Views", *Nature*, 412(6845):389–91. (PDF)
- Gibson, J. J. (1966). *The Senses Considered as Perceptual Systems*, Houghton Mifflin.
- Gibson, J. J. (1987). *The Ecological Approach to Visual Perception*. Lawrence Erlbaum Associates. ISBN 0-89859-959-8
- Robles-De-La-Torre, G. (2006). "The Importance of the Sense of Touch in Virtual and Real Environments". IEEE Multimedia,13(3), Special issue on Haptic User Interfaces for Multimedia Systems, pp. 24–30. (PDF)

TOC Previous

External links

Find more about

Perception

at Wikipedia's sister projects

Definitions from Wiktionary

Media from Wikimedia Commons

News from Wikinews

Quotations from Wikiquote

Texts from Wikisource

Textbooks from Wikibooks

Learning resources from Wikiversity

- Theories of Perception Several different aspects on perception
- Richard L Gregory Theories of Richard. L. Gregory.
- Comprehensive set of optical illusions, presented by Michael Bach.
- Optical Illusions Examples of well-known optical illusions.

Categories: Experimental psychology | Sensory systems | Subjective experience | Concepts in epistemology | Cognitive science | Mental processes | Neuropsychological assessment | Perception | Sources of knowledge | Unsolved problems in neuroscience

This page was last edited on 14 May 2018, at 17:56.

Back to main TOC

Contents

Theory of Mind

Jump to navigation Jump to search

Theory of mind is the ability to attribute mental states— beliefs, intents, desires, emotions, knowledge, etc.—to oneself, and to others, and to understand that others have beliefs, desires, intentions, and perspectives that are different from one's own.[1] Theory of mind is crucial for everyday social interactions and is used when analyzing, judging, and inferring others' behaviors.[2] Deficits can occur in people with autism spectrum disorders, schizophrenia, attention deficit hyperactivity disorder,[3] cocaine addiction,[4] and brain damage suffered from alcohol's neurotoxicity.[5] Although philosophical approaches to this exist, the theory of mind as such is distinct from the philosophy of mind.

Definition

Theory of mind is a theory insofar as the mind is the only thing being directly observed.[1] The presumption that others have a mind is termed a theory of mind because each human can only intuit the existence of their own mind through introspection, and no one has direct access to the mind of another. It is typically assumed that others have minds analogous to one's own, and this assumption is based on the reciprocal, social interaction, as observed in joint attention,[6] the functional use of language,[7] and the understanding of others' emotions and actions.[8] Having theory of mind allows one to attribute thoughts, desires, and intentions to others, to predict or explain their actions, and to posit their intentions. As originally defined, it enables one to understand that mental states can be the cause of—and thus be used to explain and predict—the behavior of others.[1] Being able to attribute mental states to others and understanding them as causes of behavior implies, in part, that one must be able to conceive of the mind as a "generator of representations".[9][10] If a person does not have a complete theory of mind, it may be a sign of cognitive or developmental impairment.

Theory of mind appears to be an innate potential ability in primates including humans, that requires social and other experience over many years for its full development. Different people may develop more, or less, effective theory of mind. Neo-Piagetian theories of cognitive development maintain that theory of mind is a byproduct of a broader hypercognitive ability of the human mind to register, monitor, and represent its own functioning.[11]

Empathy is a related concept, meaning the recognition and understanding of the states of mind of others, including their beliefs, desires and particularly emotions. This is often characterized as the ability to "put oneself into another's shoes". Recent neuro-ethological studies of animal behaviour suggest that even rodents may exhibit ethical or empathetic abilities.[12] While empathy is known as emotional perspective-taking, theory of mind is defined as cognitive perspective-taking.[13]

Research on theory of mind, in humans and animals, adults and children, normally and atypically developing, has grown rapidly in the 35 years since Premack and Guy Woodruff's paper, "Does the chimpanzee have a theory of mind?".[1] The emerging field of social neuroscience has also begun to address this debate, by imaging the brains of humans while they perform tasks demanding the understanding of an intention, belief or other mental state in others.

An alternative account of theory of mind is given within operant psychology and provides significant empirical evidence for a functional account of both perspective-taking and empathy. The most developed operant approach is founded on research on derived relational responding and is subsumed within what is called "relational frame theory". According to this view, empathy and perspective-taking comprise a complex set of derived relational abilities based on learning to discriminate and respond verbally to ever more complex relations between self, others, place, and time, and through established relations.[14][15][16]

TOC Previous Next

Philosophical and psychological roots

Contemporary discussions of Theory of Mind have their roots in philosophical debate—most broadly, from the time of Descartes' *Second Meditation*, which set the groundwork for considering the science of the mind. Most prominent recently are two contrasting approaches in the philosophical literature, to theory of mind: **theory-theory** and **simulation theory**. The theory-theorist imagines a veritable theory—"folk psychology"—used to reason about others' minds. The theory is developed automatically and innately, though instantiated through social interactions.[17] It is also closely related to person perception and attribution theory from social psychology.

The intuitive assumption that others are minded is an apparent tendency we all share. We anthropomorphize non-human animals, inanimate objects, and even natural phenomena. Daniel Dennett referred to this tendency as taking an "intentional stance" toward things: we assume they have intentions, to help predict future behavior.[18] However, there is an important distinction between taking an "intentional stance" toward something and entering a "shared world" with it. The intentional stance is a detached and functional theory we resort to during interpersonal interactions. A shared world is directly perceived and its existence structures reality itself for the perceiver. It is not just automatically applied to perception; it in many ways constitutes perception.

The philosophical roots of the relational frame theory (RFT) account of Theory of Mind arise from contextual psychology and refer to the study of organisms (both human and non-human) interacting in and with a historical and current situational context. It is an approach based on contextualism, a philosophy in which any event is interpreted as an ongoing act inseparable from its current and historical context and in which a radically functional approach to truth and meaning is adopted. As a variant of contextualism, RFT focuses on the construction of practical, scientific knowledge. This scientific form of contextual psychology is virtually synonymous with the philosophy of operant psychology.[19]

Development

The study of which animals are capable of attributing knowledge and mental states to others, as well as the development of this ability in human ontogeny and phylogeny, has identified several behavioral precursors to theory of mind. Understanding attention, understanding of others' intentions, and imitative experience with other people are hallmarks of a theory of mind that may be observed early in the development of what later becomes a full-fledged theory. In studies with non-human animals and pre-verbal humans, in particular, researchers look to these behaviors preferentially in making inferences about mind.

Simon Baron-Cohen identified the infant's understanding of attention in others, a social skill found by 7 to 9 months of age, as a "critical precursor" to the development of theory of mind.[6] Understanding attention involves understanding that seeing can be directed selectively as attention, that the looker assesses the seen object as "of interest", and that seeing can induce beliefs. Attention can be directed and shared by the act of pointing, a joint attention behavior that requires taking into account another person's mental state, particularly whether the person notices an object or finds it of interest. Baron-Cohen speculates that the inclination to spontaneously reference an object in the world as of interest ("protodeclarative pointing") and to likewise appreciate the directed attention and interests of another may be the underlying motive behind all human communication.[6]

Understanding of others' intentions is another critical precursor to understanding other minds because intentionality, or "aboutness", is a fundamental feature of mental states and events. The "intentional stance" has been defined by Daniel Dennett[20] as an understanding that others' actions are goal-directed and arise from particular beliefs or desires. Both 2- and 3-year-old children could discriminate when an experimenter intentionally vs. accidentally marked a box with stickers as baited.[21] Even earlier in ontogeny, Andrew N. Meltzoff found that 18-month-old infants could perform target manipulations that adult experimenters attempted and failed, suggesting the infants could represent the object-

manipulating behavior of adults as involving goals and intentions.[22] While attribution of intention (the box-marking) and knowledge (false-belief tasks) is investigated in young humans and nonhuman animals to detect precursors to a theory of mind, Gagliardi et al. have pointed out that even adult humans do not always act in a way consistent with an attributional perspective.[23] In the experiment, adult human subjects made choices about baited containers when guided by confederates who could not see (and therefore, not know) which container was baited.

Recent research in developmental psychology suggests that the infant's ability to imitate others lies at the origins of both theory of mind and other social-cognitive achievements like perspective-taking and empathy.[24] According to Meltzoff, the infant's innate understanding that others are "like me" allows it to recognize the equivalence between the physical and mental states apparent in others and those felt by the self. For example, the infant uses his own experiences, orienting his head/eyes toward an object of interest to understand the movements of others who turn toward an object, that is, that they will generally attend to objects of interest or significance. Some researchers in comparative disciplines have hesitated to put a too-ponderous weight on imitation as a critical precursor to advanced human social-cognitive skills like mentalizing and empathizing, especially if true imitation is no longer employed by adults. A test of imitation by Alexandra Horowitz[25] found that adult subjects imitated an experimenter demonstrating a novel task far less closely than children did. Horowitz points out that the precise psychological state underlying imitation is unclear and cannot, by itself, be used to draw conclusions about the mental states of humans.

While much research has been done on infants, theory of mind develops continuously throughout childhood and into late adolescence as the synapses (neuronal connections) in the prefrontal cortex develop. The prefrontal cortex is responsible for planning and decision-making.[26] Children seem to develop theory of mind skills sequentially. The first skill to develop is the ability to recognize that others have diverse desires. Children are able to recognize that others have diverse beliefs soon after. The next skill to develop is recognizing that others have access to different knowledge bases. Finally, children are able to understand that others may

have false beliefs and that others are capable of hiding emotions. While this sequence represents the general trend in skill acquisition, it seems that more emphasis is placed on some skills in certain cultures, leading to more valued skills to develop before those that are considered not as important. For example, in individualistic cultures such as the United States, a greater emphasis is placed on the ability to recognize that others have different opinions and beliefs. In a collectivistic culture, such as China, this skill may not be as important and therefore may not develop until later.[27]

Language

There is evidence to believe that the development of theory of mind is closely intertwined with language development in humans. One meta-analysis showed a moderate to strong correlation ($r = 0.43$) between performance on theory of mind and language tasks.[28] One might argue that this relationship is due solely to the fact that both language and theory of mind seem to begin to develop substantially around the same time in children (between ages 2–5). However, many other abilities develop during this same time period as well, and do not produce such high correlations with one another nor with theory of mind. There must be something else going on to explain the relationship between theory of mind and language.

Carol A. Miller posed a few possible explanations for this relationship. One idea was that the extent of verbal communication and conversation involving children in a family could explain theory of mind development. The belief is that this type of language exposure could help introduce a child to the different mental states and perspectives of others.[29] This has been suggested empirically by findings indicating that participation in family discussion predict scores on theory of mind tasks,[30] as well as findings showing that deaf children who have hearing parents and may not be able to communicate with their parents much during early years of development tend to score lower on theory of mind tasks.[31]

Another explanation of the relationship between language and theory of mind development has to do with a child's understanding of mental state words such as "*think*" and "*believe*". Since a mental state is not something

that one can observe from behavior, children must learn the meanings of words denoting mental states from verbal explanations alone, requiring knowledge of the syntactic rules, semantic systems, and pragmatics of a language.[29] Studies have shown that understanding of these mental state words predicts theory of mind in four-year-olds.[32]

A third hypothesis is that the ability to distinguish a whole sentence ("Jimmy thinks the world is flat") from its embedded complement ("the world is flat") and understand that one can be true while the other can be false is related to theory of mind development. Recognizing these sentential complements as being independent of one another is a relatively complex syntactic skill and has been shown to be related to increased scores on theory of mind tasks in children.[33]

In addition to these hypotheses, there is also evidence that the neural networks between the areas of the brain responsible for language and theory of mind are closely connected. The temporoparietal junction has been shown to be involved in the ability to acquire new vocabulary, as well as perceive and reproduce words. The temporoparietal junction also contains areas that specialize in recognizing faces, voices, and biological motion, in addition to theory of mind. Since all of these areas are located so closely together, it is reasonable to conclude that they work together. Moreover, studies have reported an increase in activity in the TPJ when patients are absorbing information through reading or images regarding other peoples' beliefs but not while observing information about physical control stimuli.[34]

TOC Previous Next

Aging

In older age, theory of mind capacities decline, irrespective of how exactly they are tested (e.g. stories, eyes, videos, false belief-video, false belief-other, faux pas).[35] However, the decline in other cognitive functions is even stronger, suggesting that social cognition is somewhat preserved. In contrast to theory of mind, empathy shows no impairments in aging.[36]

There are two kinds of theory of mind representations: cognitive

(concerning the mental states, beliefs, thoughts, and intentions of others) and affective (concerning the emotions of others). Cognitive theory of mind is further separated into first order (e.g., I think she thinks that…) and second order (e.g., he thinks that she thinks that…). There is evidence that cognitive and affective theory of mind processes are functionally independent from one another.[37] In studies of Alzheimer's disease, which typically occurs in older adults, the patients display impairment with second order cognitive theory of mind, but usually not with first order cognitive or affective theory of mind. However, it is difficult to discern a clear pattern of theory of mind variation due to age. There have been many discrepancies in the data collected thus far, likely due to small sample sizes and the use of different tasks that only explore one aspect of theory of mind. Many researchers suggest that the theory of mind impairment is simply due to the normal decline in cognitive function.[38]

Cultural variations

Researchers have proposed that five key aspects of theory of mind develop sequentially for all children between the ages of three to five.[39] This five-step theory of mind scale consists of the development of diverse desires (DD), diverse beliefs (DB), knowledge access (KA), false beliefs (FB), and hidden emotions (HE).[39] Australian, American and European children acquire theory of mind in this exact order,[40] and studies with children in Canada, India, Peru, Samoa, and Thailand indicate that they all pass the false belief task at around the same time, suggesting that the children develop theory of mind consistently around the world.[41]

However, children from Iran and China develop theory of mind in a slightly different order. Although they begin the development of theory of mind around the same time, toddlers from these countries understand knowledge access (KA) before Western children but take longer to understand false beliefs (FB).[40][42] Researchers believe this swap in the developmental order is related to the culture of collectivism in Iran and China, which emphasizes interdependence and shared knowledge as opposed to the culture of individualism in Western countries, which

promotes individuality and conflicting opinions. Because of these different cultural values, Iranian and Chinese children might take longer to understand that other people have different, sometimes false, beliefs. This suggests that the development of theory of mind is not universal and solely determined by innate brain processes but also influenced by social and cultural factors.[40]

TOC Previous Next

Empirical investigation

Whether children younger than 3 or 4 years old may have any theory of mind is a topic of debate among researchers. It is a challenging question, due to the difficulty of assessing what pre-linguistic children understand about others and the world. Tasks used in research into the development of Theory of Mind must take into account the *umwelt*—(the German word *Umwelt* means "environment" or "surrounding world")—of the pre-verbal child.[*clarification needed*]

TOC Previous Next

False-belief task

One of the most important milestones in theory of mind development is gaining the ability to attribute *false belief*: that is, to recognize that others can have beliefs about the world that are diverging. To do this, it is suggested, one must understand how knowledge is formed, that people's beliefs are based on their knowledge, that mental states can differ from reality, and that people's behavior can be predicted by their mental states. Numerous versions of the false-belief task have been developed, based on the initial task done by Wimmer and Perner (1983).[43]

In the most common version of the false-belief task (often called the "'Sally-Anne' test" or "'Sally-Anne' task"), children are told or shown a story involving two characters. For example, the child is shown two dolls, Sally and Anne, who have a basket and a box, respectively. Sally also has a marble, which she places into her basket, and then leaves the room. While she is out of the room, Anne takes the marble from the basket and puts it into the box. Sally returns, and the child is then asked where Sally will look for the marble. The child passes the task if she answers that Sally will look in the basket, where Sally put the marble; the child fails the task if she answers that Sally will look in the box, where the child knows the marble is hidden, even though Sally cannot know this, since she did not see it hidden there. To pass the task, the child must be able to understand that another's mental representation of the situation is different from their own,

and the child must be able to predict behavior based on that understanding. Another example is when a boy leaves chocolate on a shelf and then leaves the room. His mother puts it in the fridge. To pass the task, the child must understand that the boy, upon returning, holds the false belief that his chocolate is still on the shelf.[44]

The results of research using false-belief tasks have been fairly consistent: most normally developing children are able to pass the tasks from around age four.[45] Notably, while most children, including those with Down syndrome, are able to pass this test, in one study, 80% of children diagnosed with autism were *unable* to do so.[46]

Also adults can experience problems with false beliefs. For instance, when they show hindsight bias, defined as: "the inclination to see events that have already happened as being more predictable than they were before they took place."[47] In an experiment by Fischhoff in 1975, adult subjects who were asked for an independent assessment were unable to disregard information on actual outcome. Also in experiments with complicated situations, when assessing others' thinking, adults can be unable to disregard certain information that they have been given.[44]

TOC Previous Next

Unexpected contents

Other tasks have been developed to try to solve the problems inherent in the false-belief task. In the "Unexpected contents", or "Smarties" task, experimenters ask children what they believe to be the contents of a box that looks as though it holds a candy called " Smarties". After the child guesses (usually) "Smarties", it is shown that the box in fact contained pencils. The experimenter then re-closes the box and asks the child what she thinks another person, who has not been shown the true contents of the box, will think is inside. The child passes the task if he/she responds that another person will think that "Smarties" exist in the box, but fails the task if she responds that another person will think that the box contains pencils. Gopnik & Astington (1988)[48] found that children pass this test at age four or five years.

Other tasks

The "false-photograph" task[49][50] is another task that serves as a measure of theory of mind development. In this task, children must reason about what is represented in a photograph that differs from the current state of affairs. Within the false-photograph task, either a location or identity change exists.[51] In the location-change task, the examiner puts an object in one location (*e.g.*, chocolate in an open green cupboard), whereupon the child takes a Polaroid photograph of the scene. While the photograph is developing, the examiner moves the object to a different location (*e.g.*, a blue cupboard), allowing the child to view the examiner's action. The examiner asks the child two control questions: "When we first took the picture, where was the object?" and "Where is the object now?". The subject is also asked a "false-photograph" question: "Where is the object in the picture?" The child passes the task if he/she correctly identifies the location of the object in the picture and the actual location of the object at the time of the question. However, the last question might be misinterpreted as: "Where in this room is the object that the picture depicts?" and therefore some examiners use an alternative phrasing.[*citation needed*]

To make it easier for animals, young children, and individuals with classical (Kanner-type) autism to understand and perform theory of mind tasks, researchers have developed tests in which verbal communication is de-emphasized: some whose administration does not involve verbal communication on the part of the examiner, some whose successful completion does not require verbal communication on the part of the subject, and some that meet both of the foregoing standards. One category of tasks uses a preferential looking paradigm, with looking time as the dependent variable. For instance, 9-month-old infants prefer looking at behaviors performed by a human hand over those made by an inanimate hand-like object.[52] Other paradigms look at rates of imitative behavior, the ability to replicate and complete unfinished goal-directed acts,[22] and rates of pretend play.[53]

Early precursors

Recent research on the early precursors of theory of mind has looked at innovative ways at capturing preverbal infants' understanding of other people's mental states, including perception and beliefs. Using a variety of experimental procedures, studies have shown that infants in their second year of life have an implicit understanding of what other people see[54] and what they know.[55] A popular paradigm used to study infants' theory of mind is the violation of expectation procedure, which predicates on infants' tendency to look longer at unexpected and surprising events compared to familiar and expected events. Therefore, their looking-times measures would give researchers an indication of what infants might be inferring, or their implicit understanding of events. One recent study using this paradigm found that 16-month-olds tend to attribute beliefs to a person whose visual perception was previously witnessed as being "reliable", compared to someone whose visual perception was "unreliable". Specifically, 16-month-olds were trained to expect a person's excited vocalization and gaze into a container to be associated with finding a toy in the reliable-looker condition or an absence of a toy in the unreliable-looker condition. Following this training phase, infants witnessed, in an object-search task, the same persons either searching for a toy in the correct or incorrect location after they both witnessed the location of where the toy was hidden. Infants who experienced the reliable looker were surprised and therefore looked longer when the person searched for the toy in the incorrect location compared to the correct location. In contrast, the looking time for infants who experienced the unreliable looker did not differ for either search locations. These findings suggest that 16-month-old infants can differentially attribute beliefs about a toy's location based on the person's prior record of visual perception.[56]

Deficits

The theory of mind impairment describes a difficulty someone would have with perspective-taking. This is also sometimes referred to as *mind-blindness*. This means that individuals with a theory of mind impairment would have a difficult time seeing phenomena from any other perspective than their own.[57] Individuals who experience a theory of mind deficit have difficulty determining the intentions of others, lack understanding of how their behavior affects others, and have a difficult time with social reciprocity.[58] Theory of Mind deficits have been observed in people with autism spectrum disorders, people with schizophrenia, people with nonverbal learning disorder, people with attention deficit disorder,[3] persons under the influence of alcohol and narcotics, sleep-deprived persons, and persons who are experiencing severe emotional or physical pain. Theory of mind deficits have also been observed in deaf children who are late signers (i.e., are born to hearing parents), but the deficit is due to the delay in language learning, not any cognitive deficit, and therefore disappears once the child learns sign language.[59]

TOC Previous Next

Autism

In 1985 Simon Baron-Cohen, Alan M. Leslie and Uta Frith suggested that children with autism do not employ theory of mind[46] and suggested that autistic children have particular difficulties with tasks requiring the child to understand another person's beliefs. These difficulties persist when children are matched for verbal skills[60] and have been taken as a key feature of autism.

Many individuals classified as autistic have severe difficulty assigning mental states to others, and they seem to lack theory of mind capabilities.[61] Researchers who study the relationship between autism and theory of mind attempt to explain the connection in a variety of ways. One account assumes that theory of mind plays a role in the attribution of mental states

to others and in childhood pretend play.[62] According to Leslie,[62] theory of mind is the capacity to mentally represent thoughts, beliefs, and desires, regardless of whether or not the circumstances involved are real. This might explain why some autistic individuals show extreme deficits in both theory of mind and pretend play. However, Hobson proposes a social-affective justification,[63] which suggests that with an autistic person, deficits in theory of mind result from a distortion in understanding and responding to emotions. He suggests that typically developing human beings, unlike autistic individuals, are born with a set of skills (such as social referencing ability) that later lets them comprehend and react to other people's feelings. Other scholars emphasize that autism involves a specific developmental delay, so that autistic children vary in their deficiencies, because they experience difficulty in different stages of growth. Very early setbacks can alter proper advancement of joint-attention behaviors, which may lead to a failure to form a full theory of mind.[61]

It has been speculated[53] that Theory of Mind exists on a continuum as opposed to the traditional view of a discrete presence or absence. While some research has suggested that some autistic populations are unable to attribute mental states to others,[6] recent evidence points to the possibility of coping mechanisms that facilitate a spectrum of mindful behavior.[64] Tine et al. suggest that autistic children score substantially lower on measures of social theory of mind in comparison to children diagnosed with Asperger syndrome.[65]

Generally, children with more advanced theory of mind abilities display more advanced social skills, greater adaptability to new situations, and greater cooperation with others. As a result, these children are typically well-liked. However, “children may use their mind-reading abilities to manipulate, outwit, tease, or trick their peers”.[66] Individuals possessing inferior theory of mind skills, such as children with autism spectrum disorder, may be socially rejected by their peers since they are unable communicate effectively. Social rejection has been proven to negatively impact a child’s development and can put the child at greater risk of developing depressive symptoms.[67]

Peer-mediated interventions (PMI) are a school-based treatment approach for children and adolescents with autism spectrum disorder in which peers are trained to be role models in order to promote social behavior. Laghi et al. studied if analysis of prosocial (nice) and antisocial (nasty) theory of mind behaviors could be used, in addition to teacher recommendations, to select appropriate candidates for PMI programs. Selecting children with advanced theory of mind skills who use them in prosocial ways will theoretically make the program more effective. While the results indicated that analyzing the social uses of theory of mind of possible candidates for a PMI program is invaluable, it may not be a good predictor of a candidate's performance as a role model.[26]

Schizophrenia

Individuals with the diagnosis of schizophrenia can show deficits in theory of mind. Mirjam Sprong and colleagues investigated the impairment by examining 29 different studies, with a total of over 1500 participants.[68] This meta-analysis showed significant and stable deficit of theory of mind in people with schizophrenia. They performed poorly on false-belief tasks, which test the ability to understand that others can hold false beliefs about events in the world, and also on intention-inference tasks, which assess the ability to infer a character's intention from reading a short story. Schizophrenia patients with negative symptoms, such as lack of emotion, motivation, or speech, have the most impairment in theory of mind and are unable to represent the mental states of themselves and of others. Paranoid schizophrenic patients also perform poorly because they have difficulty accurately interpreting others' intentions. The meta-analysis additionally showed that IQ, gender, and age of the participants does not significantly affect the performance of theory of mind tasks.[68]

Current research suggests that impairment in theory of mind negatively affects clinical insight, the patient's awareness of their mental illness.[69] Insight requires theory of mind—a patient must be able to adopt a third-person perspective and see the self as others do.[70] A patient with good insight would be able to accurately self-represent, by comparing oneself with others and by viewing oneself from the perspective of others.[69] Insight allows a patient to recognize and react appropriately to his symptoms; however, a patient who lacks insight would not realize that he has a mental illness, because of his inability to accurately self-represent. Therapies that teach patients perspective-taking and self-reflection skills can improve abilities in reading social cues and taking the perspective of another person.[69]

The majority of the current literature supports the argument that the theory of mind deficit is a stable trait-characteristic rather than a state-characteristic of schizophrenia.[71] The meta-analysis conducted by Sprong et al. showed that patients in remission still had impairment in theory of mind. The results indicate that the deficit is not merely a consequence of the active phase of schizophrenia.[68]

Schizophrenic patients' deficit in theory of mind impairs their daily interactions with others. An example of a disrupted interaction is one between a schizophrenic parent and a child. Theory of mind is particularly important for parents, who must understand the thoughts and behaviors of their children and react accordingly. Dysfunctional parenting is associated with deficits in the first-order theory of mind, the ability to understand another person's thoughts, and the second-order theory of mind, the ability to infer what one person thinks about another person's thoughts.[72] Compared with healthy mothers, mothers with schizophrenia are found to be more remote, quiet, self-absorbed, insensitive,

unresponsive, and to have fewer satisfying interactions with their children.[72] They also tend to misinterpret their children's emotional cues, and often misunderstand neutral faces as negative.[72] Activities such as role-playing and individual or group-based sessions are effective interventions that help the parents improve on perspective-taking and theory of mind.[72] Although there is a strong association between theory of mind deficit and parental role dysfunction, future studies could strengthen the relationship by possibly establishing a causal role of theory of mind on parenting abilities.

TOC | ← Previous | Next →

Alcohol use disorders

Impairments in theory of mind, as well as other social-cognitive deficits are commonly found in people suffering from alcoholism, due to the neurotoxic effects of alcohol on the brain, particularly the prefrontal cortex.[5]

TOC | ← Previous | Next →

Depression and dysphoria

Individuals in a current major depressive episode, a disorder characterized by social impairment, show deficits in theory of mind decoding.[73] Theory of mind decoding is the ability to use information available in the immediate environment (e.g., facial expression, tone of voice, body posture) to accurately label the mental states of others. The opposite pattern, enhanced theory of mind, is observed in individuals vulnerable to depression, including those individuals with past Major Depressive Disorder (MDD),[*citation needed*] dysphoric individuals,[74] and individuals with a maternal history of MDD.[75]

TOC | ← Previous | Next →

Specific language impairment

Children diagnosed with specific language impairment (SLI) exhibit much lower scores on reading and writing sections of standardized tests, yet have a normal nonverbal IQ. These language deficits can be any specific deficits in lexical semantics, syntax, or pragmatics, or a combination of multiple problems. They often exhibit poorer social skills than normally developing children, and seem to have problems decoding beliefs in others. A recent meta-analysis confirmed that children with SLI have substantially lower scores on theory of mind tasks compared to typically developing children. [76] This strengthens the claim that language development is related to theory of mind.

TOC | ← Previous | Next →

Brain mechanisms

In typically developing humans

Research on theory of mind in autism led to the view that mentalizing abilities are subserved by dedicated mechanisms that can -in some cases- be impaired while general cognitive function remains largely intact.

Neuroimaging research has supported this view, demonstrating specific brain regions consistently engaged during theory of mind tasks. PET research on theory of mind, using verbal and pictorial story comprehension tasks, has identified a set of brain regions including the medial prefrontal cortex (mPFC), and area around posterior superior temporal sulcus (pSTS), and sometimes precuneus and amygdala/temporopolar cortex.[77] Subsequently, research on the neural basis of theory of mind has diversified, with separate lines of research focused on the understanding of beliefs, intentions, and more complex properties of minds such as psychological traits.

Studies from Rebecca Saxe's lab at MIT, using a false-belief versus false-photograph task contrast aimed at isolating the mentalizing component of the false-belief task, have very consistently found activation in mPFC, precuneus, and temporo-parietal junction (TPJ), right-lateralized.[78][79] In particular, it has been proposed that the right TPJ (rTPJ) is selectively involved in representing the beliefs of others.[80] However, some debate exists, as some scientists have noted that the same rTPJ region has been consistently activated during spatial reorienting of visual attention;[81][82] Jean Decety from the University of Chicago and Jason Mitchell from Harvard have thus proposed that the rTPJ subserves a more general function involved in both false-belief understanding and attentional reorienting, rather than a mechanism specialized for social cognition. However, it is possible that the observation of overlapping regions for representing beliefs and attentional reorienting may simply be due to adjacent, but distinct, neuronal populations that code for each. The resolution of typical fMRI studies may not be good enough to show that distinct/adjacent neuronal populations code for each of these processes. In a study following Decety and Mitchell, Saxe and colleagues used higher-resolution fMRI and showed that the peak of activation for attentional reorienting is approximately 6-10mm above the peak for representing beliefs. Further corroborating that differing populations of neurons may code for each process, they found no similarity in the patterning of fMRI response across space.[83]

Functional imaging has also been used to study the detection of mental state information in Heider-Simmel-esque animations of moving geometric shapes, which typical humans automatically perceive as social interactions laden with intention and emotion. Three studies found remarkably similar patterns of

activation during the perception of such animations versus a random or deterministic motion control: mPFC, pSTS, fusiform face area (FFA), and amygdala were selectively engaged during the Theory of Mind condition.[84][85][86] Another study presented subjects with an animation of two dots moving with a parameterized degree of intentionality (quantifying the extent to which the dots chased each other), and found that pSTS activation correlated with this parameter.[87]

A separate body of research has implicated the posterior superior temporal sulcus in the perception of intentionality in human action; this area is also involved in perceiving biological motion, including body, eye, mouth, and point-light display motion.[88] One study found increased pSTS activation while watching a human lift his hand versus having his hand pushed up by a piston (intentional versus unintentional action).[89] Several studies have found increased pSTS activation when subjects perceive a human action that is incongruent with the action expected from the actor's context and inferred intention. Examples would be: a human performing a reach-to-grasp motion on empty space next to an object, versus grasping the object;[90] a human shifting eye gaze toward empty space next to a checkerboard target versus shifting gaze toward the target;[91] an unladen human turning on a light with his knee, versus turning on a light with his knee while carrying a pile of books;[92] and a walking human pausing as he passes behind a bookshelf, versus walking at a constant speed.[93] In these studies, actions in the "congruent" case have a straightforward goal, and are easy to explain in terms of the actor's intention. The incongruent actions, on the other hand, require further explanation (why would someone twist empty space next to a gear?), and then apparently would demand more processing in the STS. Note that this region is distinct from the temporo-parietal area activated during false belief tasks.[93] Also note that pSTS activation in most of the above studies was largely right-lateralized, following the general trend in neuroimaging studies of social cognition and perception. Also right-lateralized are the TPJ activation during false belief tasks, the STS response to biological motion, and the FFA response to faces.

Neuropsychological evidence has provided support for neuroimaging results regarding the neural basis of theory of mind. Studies with patients suffering from a lesion of the frontal lobes and the temporoparietal junction of the brain (between the temporal lobe and parietal lobe) reported that they have difficulty with some theory of mind tasks.[94][95] This shows that theory of mind abilities are associated with specific parts of the human brain. However, the fact that the medial prefrontal cortex and temporoparietal junction are necessary for theory of mind tasks does not imply that these regions are specific to that function.[81][96] TPJ and mPFC may subserve more general functions necessary for Theory of Mind.

Research by Vittorio Gallese, Luciano Fadiga and Giacomo Rizzolatti (reviewed in[97]) has

shown that some sensorimotor neurons, which are referred to as mirror neurons, first discovered in the premotor cortex of rhesus monkeys, may be involved in action understanding. Single-electrode recording revealed that these neurons fired when a monkey performed an action, as well as when the monkey viewed another agent carrying out the same task. Similarly, fMRI studies with human participants have shown brain regions (assumed to contain mirror neurons) that are active when one person sees another person's goal-directed action.[98] These data have led some authors to suggest that mirror neurons may provide the basis for theory of mind in the brain, and to support simulation theory of mind reading (see above).[99]

However, there is also evidence against the link between mirror neurons and theory of mind. First, macaque monkeys have mirror neurons but do not seem to have a 'human-like' capacity to understand theory of mind and belief. Second, fMRI studies of theory of mind typically report activation in the mPFC, temporal poles and TPJ or STS,[100] but these brain areas are not part of the mirror neuron system. Some investigators, like developmental psychologist Andrew Meltzoff and neuroscientist Jean Decety, believe that mirror neurons merely facilitate learning through imitation and may provide a precursor to the development of Theory of Mind.[101][102] Others, like philosopher Shaun Gallagher, suggest that mirror-neuron activation, on a number of counts, fails to meet the definition of simulation as proposed by the simulation theory of mindreading.[103][104]

However, in a recent paper, Keren Haroush and Ziv Williams outlined the case for a group of neurons in primates' brains that uniquely predicted the choice selection of their interacting partner. These primates' neurons, located in the anterior cingulate cortex of rhesus monkeys, were observed using single-unit recording while the monkeys played a variant of the iterative prisoner's dilemma game.[105] By identifying cells that represent the yet unknown intentions of a game partner, Haroush & Williams' study supports the idea that theory of mind may be a fundamental and generalized process, and suggests that *anterior cingulate cortex* neurons may potentially act to complement the function of mirror neurons during social interchange.[106]

☰ TOC | ← Previous | Next →

In autism

Several neuroimaging studies have looked at the neural basis theory of mind impairment in subjects with Asperger syndrome and high-functioning autism (HFA). The first PET study of theory of mind in autism (also the first neuroimaging study using a task-induced activation paradigm in autism) replicated a prior study in normal individuals, which employed a story-comprehension task.[107][108] This study found displaced and diminished mPFC activation in subjects with autism. However, because the study used only six subjects with autism, and because the spatial resolution of PET imaging is

relatively poor, these results should be considered preliminary.

A subsequent fMRI study scanned normally developing adults and adults with HFA while performing a "reading the mind in the eyes" task: viewing a photo of a human's eyes and choosing which of two adjectives better describes the person's mental state, versus a gender discrimination control.[109] The authors found activity in orbitofrontal cortex, STS, and amygdala in normal subjects, and found no amygdala activation and abnormal STS activation in subjects with autism.

A more recent PET study looked at brain activity in individuals with HFA and Asperger syndrome while viewing Heider-Simmel animations (see above) versus a random motion control.[110] In contrast to normally developing subjects, those with autism showed no STS or FFA activation, and significantly less mPFC and amygdala activation. Activity in extrastriate regions V3 and LO was identical across the two groups, suggesting intact lower-level visual processing in the subjects with autism. The study also reported significantly less functional connectivity between STS and V3 in the autism group. Note, however, that decreased temporal correlation between activity in STS and V3 would be expected simply from the lack of an evoked response in STS to intent-laden animations in subjects with autism. A more informative analysis would be to compute functional connectivity after regressing out evoked responses from all-time series.

A subsequent study, using the incongruent/congruent gaze-shift paradigm described above, found that in high-functioning adults with autism, posterior STS (pSTS) activation was undifferentiated while they watched a human shift gaze toward a target and then toward adjacent empty space.[111] The lack of additional STS processing in the incongruent state may suggest that these subjects fail to form an expectation of what the actor should do given contextual information, or that feedback about the violation of this expectation doesn't reach STS. Both explanations involve an impairment in the ability to link eye gaze shifts with intentional explanations. This study also found a significant anticorrelation between STS activation in the incongruent-congruent contrast and social subscale score on the Autism Diagnostic Interview-Revised, but not scores on the other subscales.

In 2011, an fMRI study demonstrated that the right temporoparietal junction (rTPJ) of higher-functioning adults with autism was not more selectively activated for mentalizing judgments when compared to physical judgments about self and other.[112] rTPJ selectivity for mentalizing was also related to individual variation on clinical measures of social impairment: individuals whose rTPJ was increasingly more active for mentalizing compared to physical judgments were less socially impaired, while those who showed little to no difference in response to mentalizing or physical judgments were the most socially impaired. This evidence builds on work in typical development that suggests rTPJ is critical for representing mental state information, irrespective of whether it is about oneself or others. It also points to an explanation at the neural level for the pervasive mind-blindness difficulties in

autism that are evident throughout the lifespan.[113]

TOC ← Previous Next →

In schizophrenia

The brain regions associated with theory of mind include the superior temporal gyrus (STS), the temporoparietal junction (TPJ), the medial prefrontal cortex (MPFC), the precuneus, and the amygdala.[114] The reduced activity in the MPFC of individuals with schizophrenia is associated with the Theory of mind deficit and may explain impairments in social function among people with schizophrenia.[115] Increased neural activity in MPFC is related to better perspective-taking, emotion management, and increased social functioning.[115] Disrupted brain activities in areas related to theory of mind may increase social stress or disinterest in social interaction, and contribute to the social dysfunction associated with schizophrenia.[115]

TOC ← Previous Next →

Practical validity

Main article: Collective intelligence

Group member average scores of theory of mind abilities, measured with the Reading the Mind in the Eyes test[116] (RME), are suggested as drivers of successful group performance.[117] In particular, high group average scores on the RME are shown to be correlated with the collective intelligence factor *c* defined as a group's ability to perform a wide range of mental tasks,[117][118] a group intelligence measure similar to the *g* factor for general individual intelligence. RME is a Theory of Mind test for adults[116] that shows sufficient test-retest reliability[119] and constantly differentiates control groups from individuals with functional autism or Asperger syndrome.[116] It is one of the most widely accepted and well-validated tests for Theory of Mind abilities within adults.[120]

TOC | Previous | Next

Evolution

The evolutionary origin of theory of mind remains obscure. While many theories make claims about its role in the development of human language and social cognition few of them specify in detail any evolutionary neurophysiological precursors. A recent theory claims that Theory of Mind has its roots in two defensive reactions, namely immobilization stress and tonic immobility, which are implicated in the handling of stressful encounters and also figure prominently in mammalian childrearing practices (Tsoukalas, 2017).[121] Their combined effect seems capable of producing many of the hallmarks of theory of mind, e.g., eye-contact, gaze-following, inhibitory control and intentional attributions.

TOC ← Previous Next →

Non-human

See also: Animal consciousness and Theory of mind in animals

An open question is if other animals besides humans have a genetic endowment and social environment that allows them to acquire a theory of mind in the same way that human children do.[1] This is a contentious issue because of the problem of inferring from animal behavior the existence of thinking or of particular thoughts, or the existence of a concept of self or self-awareness, consciousness and qualia. One difficulty with non-human studies of Theory of Mind is the lack of sufficient numbers of naturalistic observations, giving insight into what the evolutionary pressures might be on a species' development of theory of mind.

Non-human research still has a major place in this field, however, and is especially useful in illuminating which nonverbal behaviors signify components of theory of mind, and in pointing to possible stepping points in the evolution of what many claim to be a uniquely human aspect of social cognition. While it is difficult to study human-like theory of mind and mental states in species whose potential mental states we have an incomplete understanding, researchers can focus on simpler components of more complex capabilities. For example, many researchers focus on animals' understanding of intention, gaze, perspective, or knowledge (or rather, what another being has seen). Call and Tomasello's study[21] that looked at understanding of intention in orangutans, chimpanzees and children showed that all three species understood the difference between accidental and intentional acts. Part of the difficulty in this line of research is that observed phenomena can often be explained as simple stimulus-response learning, as it is in the nature of any theorizers of mind to have to extrapolate internal mental states from observable behavior. Recently, most non-human theory of mind research has focused on monkeys and great apes, who are of most interest in the study of the evolution of human social cognition. Other studies relevant to attributions theory of mind have been conducted using plovers[122] and dogs,[123] and have shown preliminary evidence of understanding attention—one precursor of theory of mind—in others.

There has been some controversy over the interpretation of evidence purporting to show theory of mind ability—or inability—in animals.[124] Two examples serve as demonstration: first, Povinelli *et al.* (1990)[125] presented chimpanzees with the choice of two experimenters from whom to request food: one who had seen where food was hidden, and one who, by virtue of one of a variety of mechanisms (having a bucket or bag over his head; a blindfold over his eyes; or being turned away from the baiting) does not know, and can only guess. They found that the animals failed in most cases to differentially request food from the "knower". By contrast, Hare, Call, and Tomasello (2001)[126] found that subordinate chimpanzees were able to use the knowledge state of dominant rival chimpanzees to

determine which container of hidden food they approached. William Field and Sue Savage-Rumbaugh have no doubt that bonobos have developed Theory of Mind and cite their communications with a well known captive bonobo, Kanzi, as evidence.[127]

In a 2016 experiment, ravens *Corvus corax* were shown to take into account visual access of unseen conspecifics. It is suspected that "ravens can generalize from their own perceptual experience to infer the possibility of being seen".[128]

A 2016 study published by evolutionary anthropologist Christopher Krupenye brings new light to the existence of Theory of Mind, and particularly false beliefs, in non-human primates.[129]

See also

References

1. ^ *a b c d e* Premack, David; Woodruff, Guy (December 1978). "Does the chimpanzee have a theory of mind?". *Behavioral and Brain Sciences, special issue: Cognition and Consiousness in Nonhuman Species*. Cambridge Journals. **1** (4): 515–526. doi:10.1017/S0140525X00076512.
2. ^ Gweon, H., Saxe, R. (2013). Developmental cognitive neuroscience of Theory of Mind. *Neural Circuit Development and Function in the Brain: Comprehensive Developmental Neuroscience. Elsevier.* Ed: J. Rubenstein & P. Rakic
3. ^ *a b* Korkmaz B (May 2011). "Theory of mind and neurodevelopmental disorders of childhood". *Pediatr. Res.* **69** (5 Pt 2): 101R–8R. doi:10.1203/PDR.0b013e318212c177. PMID 21289541.
4. ^ Sanvicente-Vieira, Breno; Kluwe-Schiavon, Bruno; Corcoran, Rhiannon; Grassi-Oliveira, Rodrigo (1 March 2017). "Theory of Mind Impairments in Women With Cocaine Addiction". *J Stud Alcohol Drugs*. **78** (2): 258–267. doi:10.15288/jsad.2017.78.258. PMID 28317506.
5. ^ *a b* Uekermann J, Daum I (May 2008). "Social cognition in alcoholism: a link to prefrontal cortex dysfunction?". *Addiction*. **103** (5): 726–35. doi:10.1111/j.1360-0443.2008.02157.x. PMID 18412750.
6. ^ *a b c d* Baron-Cohen, Simon (1991), "Precursors to a theory of mind: Understanding attention in others", in Whiten, Andrew, *Natural theories of mind: evolution, development, and simulation of everyday mindreading*, Oxford, UK Cambridge, Massachusetts, USA: B. Blackwell, pp. 233–251, ISBN 9780631171942.
7. ^ Bruner, J. S. (1981). Intention in the structure of action and interaction. In L. P. Lipsitt & C. K. Rovee-Collier (Eds.), Advances in infancy research. Vol. 1 (pp. 41-56). Norwood, NJ: Ablex Publishing Corporation.
8. ^ Gordon, R. M. (1996).'Radical' simulationism. In P. Carruthers & P. K. Smith, Eds. Theories of theories of mind. Cambridge: Cambridge University Press.
9. ^ Courtin, C. (2000). "The impact of sign language on the cognitive development of deaf children: The case of theories of mind". *Journal of Deaf Studies and Deaf Education*. **5** (3): 266–276. doi:10.1093/deafed/5.3.266. PMID 15454505.
10. ^ Courtin, C.; Melot, A.-M. (2005). "Metacognitive development of deaf children: Lessons from the appearance-reality and false belief tasks". *Developmental Science*. **8** (1): 16–25. doi:10.1111/j.1467-7687.2005.00389.x. PMID 15647063.
11. ^ Demetriou, A., Mouyi, A., & Spanoudis, G. (2010). The development of mental processing. Nesselroade, J. R. (2010). Methods in the study of life-span human development: Issues and answers. In W. F. Overton (Ed.), Biology, cognition and methods across the life-span. Volume

1 of the Handbook of life-span development (pp. 36-55), Editor-in-chief: R. M. Lerner. Hoboken, NJ: Wiley.

12. ^ de Waal, Franz B.M. (2007), "Commiserating Mice" *Scientific American*, 24 June 2007
13. ^ Hynes, Catherine A.; Baird, Abigail A.; Grafton, Scott T. "Differential role of the orbital frontal lobe in emotional versus cognitive perspective-taking". *Neuropsychologia*. **44** (3): 374–383. doi:10.1016/j.neuropsychologia.2005.06.011.
14. ^ Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). Relational frame theory: A post-Skinnerian account of human language and cognition. New York: Kluwer Academic/Plenum.
15. ^ Rehfeldt, R. A., and Barnes-Holmes, Y., (2009). Derived Relational Responding: Applications for learners with autism and other developmental disabilities. Oakland, CA: New Harbinger.
16. ^ McHugh, L. & Stewart, I. (2012). The self and perspective-taking: Contributions and applications from modern behavioral science. Oakland, CA: New Harbinger.
17. ^ Carruthers, P. (1996). Simulation and self-knowledge: a defence of the theory-theory. In P. Carruthers & P.K. Smith, Eds. *Theories of theories of mind.* Cambridge: Cambridge University Press.
18. ^ Dennett, D. (1987). The Intentional Stance. Cambridge: MIT Press.
19. ^ Fox, Eric. "Functional Contextualism". Association for Contextual Behavioral Science. Retrieved March 29, 2014.
20. ^ Dennett, Daniel C. (1987). "Reprint of Intentional systems in cognitive ethology: The Panglossian paradigm defended (to p. 260)". *The Brain and Behavioral Sciences*. **6** (3): 343–390. doi:10.1017/s0140525x00016393.
21. ^ ***a b*** Call, J.; Tomasello, M. (1998). "Distinguishing intentional from accidental actions in orangutans (Pongo pygmaeus), chimpanzees (Pan troglodytes), and human children (Homo sapiens)". *Journal of Comparative Psychology*. **112** (2): 192–206. doi:10.1037/0735-7036.112.2.192. PMID 9642787.
22. ^ ***a b*** Meltzoff, A. (1995). "Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children". *Developmental Psychology*. **31** (5): 838–850. doi:10.1037/0012-1649.31.5.838. PMC 4137788 . PMID 25147406.
23. ^ Gagliardi JL, et al. (1995). "Seeing and knowing: Knowledge attribution versus stimulus control in adult humans (Homo sapiens)". *Journal of Comparative Psychology*. **109** (2): 107–114. doi:10.1037/0735-7036.109.2.107. PMID 7758287.
24. ^ Meltzoff, Andrew N. (2003), "Imitation as a mechanism of social cognition: Origins of empathy, theory of mind, and the representation of action", in Goswami, Usha, *Blackwell handbook of childhood cognitive development*, Malden, Massachusetts: Blackwell Publishers,

pp. 6–25, ISBN 9780631218401.

25. ^ Horowitz, Alexandra C. (2003). "Do humans ape? or Do apes human? Imitation and intention in humans and other animals". *Journal of Comparative Psychology*. **17** (3): 325–336. doi:10.1037/0735-7036.117.3.325.
26. ^ *a* *b* Laghi, Fiorenzo; Lonigro, Antonia; Levanto, Simona; Ferraro, Maurizio; Baumgartner, Emma; Baiocco, Roberto (2016), "The Role of Nice and Nasty Theory of Mind in Teacher-Selected Peer Models for Adolescents with Autism Spectrum Disorders", *Measurement and Evaluation in Counseling and Development*, **49** (3): 207–216, doi:10.1177/0748175615596784
27. ^ Etel, Evren; Yagmurlu, Bilge (2015), "Social Competence, Theory of Mind, and Executive Function in Institution-reared Turkish Children", *International Journal of Behavioral Development*, **39** (6): 519–529, doi:10.1177/0165025414556095
28. ^ Milligan, Karen; Astington, Janet Wilde; Dack, Lisa Ain (March–April 2007). "Language and theory of mind: meta-analysis of the relation between language ability and false-belief understanding". *Child Development*. Wiley. **78** (2): 622–646. doi:10.1111/j.1467-8624.2007.01018.x. PMID 17381794.
29. ^ *a* *b* Miller, Carol A. (May 2006). "Developmental relationships between language and theory of mind". *American Journal of Speech-Language Pathology*. ASHA. **15** (2): 142–154. doi:10.1044/1058-0360(2006/014). PMID 16782686. Pdf.[*dead link*]
30. ^ Ruffman, Ted; Slade, Lance; Crowe, Elena (May–June 2002). "The relation between children's and mothers' mental state language and theory-of-mind understanding". *Child Development*. Wiley. **73** (3): 734–751. doi:10.1111/1467-8624.00435. PMID 12038548. Pdf.
31. ^ Woolfe, Tyron; Want, Stephen C.; Siegal, Michael (May–June 2002). "Signposts to development: theory of mind in deaf children". *Child Development*. Wiley. **73** (3): 768–778. Pdf.
32. ^ Moore, Chris; Pure, Kiran; Furrow, David (June 1990). "Children's understanding of the modal expression of speaker certainty and uncertainty and its relation to the development of a representational theory of mind". *Child Development*. Wiley. **61** (3): 722–730. doi:10.1111/j.1467-8624.1990.tb02815.x. JSTOR 1130957. PMID 2364747.
33. ^ de Villiers, Jill G.; Pyers, Jennie E. (January–March 2002). "Complements to cognition: a longitudinal study of the relationship between complex syntax and false-belief-understanding". *Cognitive Development*. Elsevier. **17** (1): 1037–1060. doi:10.1016/S0885-2014(02)00073-4.
34. ^ Saxe, R; Kanwisher, N (August 2003). "People thinking about thinking people. The role of the temporo-parietal junction in "theory of mind" ". *NeuroImage*. **19** (4): 1835–42. doi:10.1016/S1053-8119(03)00230-1. PMID 12948738.

35. ^ Henry, Julie D.; Phillips, Louise H.; Ruffman, Ted; Bailey, Phoebe E. "A meta-analytic review of age differences in theory of mind". *Psychology and Aging*. **28** (3): 826–839. doi:10.1037/a0030677.
36. ^ Reiter, Andrea M. F.; Kanske, Philipp; Eppinger, Ben; Li, Shu-Chen (2017-09-08). "The Aging of the Social Mind - Differential Effects on Components of Social Understanding". *Scientific Reports*. **7** (1). doi:10.1038/s41598-017-10669-4. ISSN 2045-2322.
37. ^ Kalbe, Elke (2010), "Dissociating Cognitive from Affective Theory of Mind: A TMS Study", *Cortex*, **46** (6): 769–780, doi:10.1016/j.cortex.2009.07.010
38. ^ Duval, Céline; Piolino, Pascale; Benjanin, Alexandre; Eustache, Francis; Desgranges, Béatrice (2011), "Age Effects on Different Components of Theory of Mind", *Consciousness and Cognition*, **20** (3): 627–642, doi:10.1016/j.concog.2010.10.025
39. ^ *a b* Wellman, Henry M.; Liu, David (2004-03-01). "Scaling of Theory-of-Mind Tasks". *Child Development*. **75** (2): 523–541. doi:10.1111/j.1467-8624.2004.00691.x. ISSN 1467-8624.
40. ^ *a b c* Shahaeian, Ameneh; Peterson, Candida C.; Slaughter, Virginia; Wellman, Henry M. "Culture and the sequence of steps in theory of mind development". *Developmental Psychology*. **47** (5): 1239–1247. doi:10.1037/a0023899.
41. ^ Callaghan, T., Rochat, P., Lillard, A., Claux, M. L., Odden, H., Itakura, S., ... & Singh, S. (2005). Synchrony in the onset of mental-state reasoning: Evidence from five cultures. *Psychological Science*, *16*(5), 378-384.
42. ^ Wellman, H. M., Fang, F., Liu, D., Zhu, L., & Liu, G. (2006). Scaling of Theory-of-Mind Understandings in Chinese Children. *Psychological Science*, *17*(12), 1075–1081. https://doi.org/10.1111/j.1467-9280.2006.01830.x
43. ^ Wimmer, H.; Perner, J. (1983). "Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception". *Cognition*. **13** (1): 103–128. doi:10.1016/0010-0277(83)90004-5. PMID 6681741.
44. ^ *a b* Mitchell, Peter (2011), "Acquiring a theory of mind", in Slater, Alan; Bremner, J. Gavin, *An introduction to developmental psychology* (3rd ed.), Hoboken, New Jersey: John Wiley & Sons Inc., pp. 381–406, ISBN 9781118767207.
45. ^ Roessler, Johannes (2013). "When the Wrong Answer Makes Perfect Sense - How the Beliefs of Children Interact With Their Understanding of Competition, Goals and the Intention of Others". *University of Warwick Knowledge Centre*. August 2014. Retrieved 2013-08-15.
46. ^ *a b* Baron-Cohen, Simon; Leslie, Alan M.; Frith, Uta (October 1985). "Does the autistic child have a "theory of mind"?". *Cognition*. Elsevier. **21** (1): 37–46. doi:10.1016/0010-0277(85)90022-8. PMID 2934210. Pdf.
47. ^ Mitchell, P. (2011). Acquiring a Theory of Mind. In Alan Slater, & Gavin Bremner (eds.) An

Introduction to Developmental Psychology: Second Edition, BPS Blackwell. page 371

48. ^ Children's understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction.. *Child Development*. 1988;59(1):26–37. doi: 10.2307/1130386. PMID 3342716.
49. ^ Zaitchik, D. (1990). "When representations conflict with reality: the preschooler's problem with false beliefs and "false" photographs". *Cognition*. **35** (1): 41–68. doi:10.1016/0010-0277(90)90036-J. PMID 2340712.
50. ^ Leslie, A.; Thaiss, L. (1992). "Domain specificity in conceptual development". *Cognition*. **43** (3): 225–51. doi:10.1016/0010-0277(92)90013-8. PMID 1643814.
51. ^ Sabbagh, M.A.; Moses, L.J.; Shiverick, S (2006). "Executive functioning and preschoolers' understanding of false beliefs, false photographs, and false signs". *Child Development*. **77** (4): 1034–1049. doi:10.1111/j.1467-8624.2006.00917.x. PMID 16942504.
52. ^ Woodward, Infants selectively encode the goal object of an actor's reach, Cognition (1998)
53. ^ ***a b*** Leslie, A. M. (1991). Theory of mind impairment in autism. In A. Whiten (Ed.), Natural theories of mind: Evolution, development and simulation of everyday mindreading (pp. 63-77). Oxford: Basil Blackwell.
54. ^ Poulin-Dubois, Diane; Sodian, Beate; Metz, Ulrike; Tilden, Joanne; Schoeppner, Barbara (2007). "Out of Sight is Not Out of Mind: Developmental Changes in Infants' Understanding of Visual Perception During the Second Year". *Journal of Cognition and Development*. **8** (4): 401–425. doi:10.1080/15248370701612951.
55. ^ Onishi, K. H.; Baillargeon, R (2005). "Do 15-Month-Old Infants Understand False Beliefs?". *Science*. **308** (5719): 255–8. Bibcode: 2005Sci...308..255O. doi:10.1126/science.1107621. PMC 3357322 . PMID 15821091.
56. ^ Poulin-Dubois, Diane; Chow, Virginia (2009). "The effect of a looker's past reliability on infants' reasoning about beliefs". *Developmental Psychology*. **45** (6): 1576–82. doi:10.1037/a0016715. PMID 19899915.
57. ^ Moore, S. (2002). *Asperger Syndrome and the Elementary School Experience*. Shawnee Mission, KS: Autism Asperger Publishing Company.
58. ^ Baker, J. (2003). *Social Skills Training: for children and adolescents with Asperger Syndrome and Social-Communication Problems*. Mission, KS: Autism Asperger Publishing Company.
59. ^ Peterson, Candida; et al. (2016), "Peer Social Skills and Theory of Mind in Children with Autism, Deafness, or Typical Development", *Developmental Psychology*, **52** (1): 46–57, doi:10.1037/a0039833
60. ^ Happe, FG (1995). "The role of age and verbal ability in the theory of mind task performance

of subjects with autism". *Child Development*. **66** (3): 843–55. doi:10.2307/1131954. JSTOR 1131954. PMID 7789204.

61. ^ *a b* Baron-Cohen, Simon (1991), "Precursors to a theory of mind: Understanding attention in others", in Whiten, Andrew, *Natural theories of mind: Evolution, development, and simulation of everyday mindreading*, Cambridge, Massachusetts: Basil Blackwell, pp. 233–251, ISBN 9780631171942.
62. ^ *a b* Leslie, Alan M. (1991), "Theory of mind impairment in autism", in Whiten, Andrew, *Natural theories of mind: Evolution, development, and simulation of everyday mindreading*, Cambridge, Massachusetts: Basil Blackwell, ISBN 9780631171942.
63. ^ Hobson, R.P. (1995). *Autism and the development of mind*. Hillsdale, N.J.: Lawrence Erlbaum. ISBN 9780863772399.
64. ^ Dapretto, M.; et al. (2006). "Understanding emotions in others: mirror neuron dysfunction in children with autism spectrum disorders". *Nature Neuroscience*. **9** (1): 28–30. doi:10.1038/nn1611. PMC 3713227 . PMID 16327784.
65. ^ Tine, Michele; Lucariello, Joan (2012). "Unique Theory of Mind Differentiation in Children with Autism and Asperger Syndrome". *Autism Research and Treatment*. **2012**: 1–11. doi:10.1155/2012/505393.
66. ^ Astington, J. W. (2003), "Sometimes necessary, never sufficient: False-belief understanding and social competence", *Individual differences in theory of mind: Implications for typical and atypical development*: 13–38
67. ^ Chung, K.; Reavis, S.; Mosconi, M.; Drewry, J.; Matthews, T.; Tassé, M. J. (2007), "Peer-mediated social skills training program for young children with high-functioning autism", *Research in Developmental Disabilities*, **28** (4): 423–436, doi:10.1016/j.ridd.2006.05.002
68. ^ *a b c* Sprong, M.; Schothorst, P.; Vos, E.; Hox, J.; Van Engeland, H. (2007). "Theory of mind in schizophrenia". *British Journal of Psychiatry*. **191** (1): 5–13. doi:10.1192/bjp.bp.107.035899.
69. ^ *a b c* Ng, R.; Fish, S.; Granholm, E. (2015). "Insight and theory of mind in schizophrenia". *Psychiatry Research*. **225** (1–2): 169–174. doi:10.1016/j.psychres.2014.11.010. PMC 4269286 . PMID 25467703.
70. ^ Konstantakopoulos, G.; Ploumpidis, D.; Oulis, P.; Patrikelis, P.; Nikitopoulou, S.; Papadimitriou, G. N.; David, A. S. (2014). "The relationship between insight and theory of mind in schizophrenia". *Schizophrenia Research*. **152** (1): 217–222. doi:10.1016/j.schres.2013.11.022. PMID 24321712.
71. ^ Cassetta, B.; Goghari, V. (2014). "Theory of mind reasoning in schizophrenia patients and non-psychotic relatives". *Psychiatry Research*. **218** (1–2): 12–19.

doi:10.1016/j.psychres.2014.03.043. PMID 24745472.

72. ^ *a b c d* Mehta, U. M.; Bhagyavathi, H. D.; Kumar, C. N.; Thirthalli, J.; Gangadhar, B. N. (2014). "Cognitive deconstruction of parenting in schizophrenia: The role of theory of mind". *Australian & New Zealand Journal of Psychiatry*. **48** (3): 249–258. doi:10.1177/0004867413500350.
73. ^ Lee, L.; et al. (2005). "Mental state decoding abilities in clinical depression". *Journal of Affective Disorders*. **86** (2–3): 247–58. doi:10.1016/j.jad.2005.02.007. PMID 15935244.
74. ^ Harkness, K. L.; et al. (2005). "Enhanced accuracy of mental state decoding in dysphoric college students". *Cognition and Emotion*. **19** (7): 999–1025. doi:10.1080/02699930541000110.
75. ^ Harkness, K. L.; et al. (2011). "Maternal history of depression is associated with enhanced theory of mind ability in depressed and non-depressed women". *Psychiatry Research*. **189** (1): 91–96. doi:10.1016/j.psychres.2011.06.007. PMID 21733579.
76. ^ Nilsson, Kristine Kahr; de López, Kristine Jensen (January–February 2016). "Theory of mind in children with specific language impairment: A systematic review and meta-analysis". *Child Development*. Wiley. **87** (1): 143–153. doi:10.1111/cdev.12462. PMID 26582261.
77. ^ Gallagher, Helen L.; Frith, Christopher D. (2003). "Functional imaging of 'theory of mind' ". *Trends in Cognitive Sciences*. **7** (2): 77–83. doi:10.1016/S1364-6613(02)00025-6. PMID 12584026.
78. ^ Saxe, R; Kanwisher, N (2003). "temporo-parietal junction". *NeuroImage*. **19** (4): 1835–42. doi:10.1016/S1053-8119(03)00230-1. PMID 12948738.
79. ^ Saxe, Rebecca; Schulz, Laura E.; Jiang, Yuhong V. (2006). "Reading minds versus following rules: Dissociating theory of mind and executive control in the brain". *Social Neuroscience*. **1** (3–4): 284–98. doi:10.1080/17470910601000446. PMID 18633794.
80. ^ Saxe, R.; Powell, L. J. (2006). "It's the Thought That Counts: Specific Brain Regions for One Component of Theory of Mind". *Psychological Science*. **17** (8): 692–9. doi:10.1111/j.1467-9280.2006.01768.x. PMID 16913952.
81. ^ *a b* Decety, J.; Lamm, C. (2007). "The Role of the Right Temporoparietal Junction in Social Interaction: How Low-Level Computational Processes Contribute to Meta-Cognition". *The Neuroscientist*. **13** (6): 580–93. doi:10.1177/1073858407304654. PMID 17911216.
82. ^ Mitchell, J. P. (2007). "Activity in Right Temporo-Parietal Junction is Not Selective for Theory-of-Mind". *Cerebral Cortex*. **18** (2): 262–71. doi:10.1093/cercor/bhm051. PMID 17551089.
83. ^ Scholz, Jonathan; Triantafyllou, Christina; Whitfield-Gabrieli, Susan; Brown, Emery N.; Saxe, Rebecca (2009). Lauwereyns, Jan, ed. "Distinct Regions of Right Temporo-Parietal

Junction Are Selective for Theory of Mind and Exogenous Attention". *PLoS ONE*. **4** (3): e4869. Bibcode: 2009PLoSO...4.4869S. doi:10.1371/journal.pone.0004869. PMC 2653721 . PMID 19290043.

84. ^ Castelli, Fulvia; Happé, Francesca; Frith, Uta; Frith, Chris (2000). "Movement and Mind: A Functional Imaging Study of Perception and Interpretation of Complex Intentional Movement Patterns". *NeuroImage*. **12** (3): 314–25. doi:10.1006/nimg.2000.0612. PMID 10944414.
85. ^ Martin, Alex; Weisberg, Jill (2003). "Neural Foundations for Understanding Social and Mechanical Concepts". *Cognitive Neuropsychology*. **20** (3–6): 575–87. doi:10.1080/02643290342000005. PMC 1450338 . PMID 16648880.
86. ^ Schultz, R. T.; Grelotti, D. J.; Klin, A.; Kleinman, J.; Van Der Gaag, C.; Marois, R.; Skudlarski, P. (2003). "The role of the fusiform face area in social cognition: Implications for the pathobiology of autism". *Philosophical Transactions of the Royal Society B: Biological Sciences*. **358** (1430): 415–427. doi:10.1098/rstb.2002.1208. PMC 1693125 . PMID 12639338.
87. ^ Schultz, Johannes; Friston, Karl J.; O'Doherty, John; Wolpert, Daniel M.; Frith, Chris D. (2005). "Activation in Posterior Superior Temporal Sulcus Parallels Parameter Inducing the Percept of Animacy". *Neuron*. **45** (4): 625–35. doi:10.1016/j.neuron.2004.12.052. PMID 15721247.
88. ^ Allison, Truett; Puce, Aina; McCarthy, Gregory (2000). "Social perception from visual cues: Role of the STS region". *Trends in Cognitive Sciences*. **4** (7): 267–278. doi:10.1016/S1364-6613(00)01501-1. PMID 10859571.
89. ^ Morris, James P.; Pelphrey, Kevin A.; McCarthy, Gregory (2008). "Perceived causality influences brain activity evoked by biological motion". *Social Neuroscience*. **3** (1): 16–25. doi:10.1080/17470910701476686. PMID 18633843.
90. ^ Pelphrey, Kevin A.; Morris, James P.; McCarthy, Gregory (2004). "Grasping the Intentions of Others: The Perceived Intentionality of an Action Influences Activity in the Superior Temporal Sulcus during Social Perception". *Journal of Cognitive Neuroscience*. **16** (10): 1706–16. doi:10.1162/0898929042947900. PMID 15701223.
91. ^ Mosconi, Matthew W.; Mack, Peter B.; McCarthy, Gregory; Pelphrey, Kevin A. (2005). "Taking an "intentional stance" on eye-gaze shifts: A functional neuroimaging study of social perception in children". *NeuroImage*. **27** (1): 247–52. doi:10.1016/j.neuroimage.2005.03.027. PMID 16023041.
92. ^ Brass, Marcel; Schmitt, Ruth M.; Spengler, Stephanie; Gergely, György (2007). "Investigating Action Understanding: Inferential Processes versus Action Simulation". *Current Biology*. **17** (24): 2117–21. doi:10.1016/j.cub.2007.11.057. PMID 18083518.
93. ^ ***a b*** Saxe, R; Xiao, D.-K; Kovacs, G; Perrett, D.I; Kanwisher, N (2004). "A region of right

posterior superior temporal sulcus responds to observed intentional actions". *Neuropsychologia*. **42** (11): 1435–46. doi:10.1016/j.neuropsychologia.2004.04.015. PMID 15246282.

94. ^ Rowe, Andrea D; Bullock, Peter R; Polkey, Charles E; Morris, Robin G (2001). " 'Theory of mind' impairments and their relationship to executive functioning following frontal lobe excisions". *Brain*. **124** (3): 600–616. doi:10.1093/brain/124.3.600. PMID 11222459.
95. ^ Samson, Dana; Apperly, Ian A; Chiavarino, Claudia; Humphreys, Glyn W (2004). "Left temporoparietal junction is necessary for representing someone else's belief". *Nature Neuroscience*. **7** (5): 499–500. doi:10.1038/nn1223. PMID 15077111.
96. ^ Stone, Valerie E.; Gerrans, Philip (2006). "What's domain-specific about theory of mind?". *Social Neuroscience*. **1** (3–4): 309–19. doi:10.1080/17470910601029221. PMID 18633796.
97. ^ Rizzolatti, Giacomo; Craighero, Laila (2004). "The Mirror-Neuron System". *Annual Review of Neuroscience*. **27** (1): 169–92. doi:10.1146/annurev.neuro.27.070203.144230. PMID 15217330.
98. ^ Iacoboni, Marco; Molnar-Szakacs, Istvan; Gallese, Vittorio; Buccino, Giovanni; Mazziotta, John C.; Rizzolatti, Giacomo (2005). "Grasping the Intentions of Others with One's Own Mirror Neuron System". *PLoS Biology*. **3** (3): e79. doi:10.1371/journal.pbio.0030079. PMC 1044835 . PMID 15736981.
99. ^ Gallese, V; Goldman, A (1998). "Mirror neurons and the simulation theory of mind-reading". *Trends in Cognitive Sciences*. **2** (12): 493–501. doi:10.1016/S1364-6613(98)01262-5. PMID 21227300.
100. ^ Frith, U.; Frith, C. D. (2003). "Development and neurophysiology of mentalizing". *Philosophical Transactions of the Royal Society B: Biological Sciences*. **358** (1431): 459–73. doi:10.1098/rstb.2002.1218. PMC 1693139 . PMID 12689373.
101. ^ Meltzoff, A. N.; Decety, J. (2003). "What imitation tells us about social cognition: A rapprochement between developmental psychology and cognitive neuroscience". *Philosophical Transactions of the Royal Society B: Biological Sciences*. **358** (1431): 491–500. doi:10.1098/rstb.2002.1261. PMC 1351349 . PMID 12689375.
102. ^ Sommerville, Jessica A.; Decety, Jean (2006). "Weaving the fabric of social interaction: Articulating developmental psychology and cognitive neuroscience in the domain of motor cognition". *Psychonomic Bulletin & Review*. **13** (2): 179–200. doi:10.3758/BF03193831. PMID 16892982.
103. ^ Gallagher, Shaun (2007). "Simulation trouble". *Social Neuroscience*. **2** (3–4): 353–65. doi:10.1080/17470910601183549. PMID 18633823.
104. ^ Gallagher, Shaun (2008). "Neural Simulation and Social Cognition". *Mirror Neuron Systems*.

Mirror Neuron Systems. pp. 355–371. doi:10.1007/978-1-59745-479-7_16. ISBN 978-1-934115-34-3.

105. ^ Haroush K, Williams Z (2015). "Neuronal Prediction of Opponent's Behavior during Cooperative Social Interchange in Primates". *Cell*. **160** (6): 1233–1245. doi:10.1016/j.cell.2015.01.045. PMC 4364450 . PMID 25728667.
106. ^ Sanfey AG, Civai C, Vavra P (2015). "Predicting the other in cooperative interactions". *Trends Cogn. Sci*. **19** (7): 364–365. doi:10.1016/j.tics.2015.05.009. PMID 26055140.
107. ^ Happe, F; et al. (1996). " 'Theory of mind' in the brain. Evidence from a PET scan study of Asperger syndrome". *NeuroReport*. **8** (1): 197–201. doi:10.1097/00001756-199612200-00040. PMID 9051780.
108. ^ Fletcher, PC; et al. (1995). "Other minds in the brain: a functional imaging study of 'theory of mind' in story comprehension". *Cognition*. **57** (2): 109–128. doi:10.1016/0010-0277(95)00692-R. PMID 8556839.
109. ^ Baron-Cohen, Simon; et al. (June 1999). "Social intelligence in the normal and autistic brain: an fMRI study". *European Journal of Neuroscience*. Wiley. **11** (6): 1891–1898. doi:10.1046/j.1460-9568.1999.00621.x. PMID 10336657.
110. ^ Castelli, F; et al. (2002). "Autism, Asperger syndrome and brain mechanisms for the attribution of mental states to animated shapes". *Brain*. **125** (Pt 8): 1839–1849. doi:10.1093/brain/awf189. PMID 12135974.
111. ^ Pelphrey, KA; et al. (2005). "Neural basis of eye gaze processing deficits in autism". *Brain*. **128** (Pt 5): 1038–1048. doi:10.1093/brain/awh404. PMID 15758039.
112. ^ Specialization of right temporo-parietal junction for mentalizing and its relation to social impairments in autism. *NeuroImage*. 2011;56(3):1832–1838. doi: 10.1016/j.neuroimage.2011.02.067. PMID 21356316.
113. ^ Mindblind eyes: an absence of spontaneous theory of mind in Asperger syndrome. *Science*. 2009;325(5942):883–885. doi: 10.1126/science.1176170. PMID 19608858.
114. ^ Pedersen, A.; Koelkebeck, K.; Brandt, M.; Wee, M.; Kueppers, K. A.; Kugel, H.; Kohl, W.; Bauer, J.; Ohrmann, P. (2012). "Theory of mind in patients with schizophrenia: Is mentalizing delayed?". *Schizophrenia Research*. **137** (1–3): 224–229. doi:10.1016/j.schres.2012.02.022. PMID 22406281.
115. ^ ***a b c*** Dodell-Feder, D.; Tully, L. M.; Lincoln, S. H.; Hooker, C. I. (2013). "The neural basis of theory of mind and its relationship to social functioning and social anhedonia in individuals with schizophrenia". *NeuroImage: Clinical*. **4**: 154–163. doi:10.1016/j.nicl.2013.11.006.
116. ^ ***a b c*** Baron-Cohen, Simon; Wheelwright, Sally; Hill, Jacqueline; Raste, Yogini; Plumb, Ian (February 2001). "The "Reading the Mind in the Eyes" Test revised version: a study with

normal adults, and adults with Asperger syndrome or high-functioning autism". *Journal of Child Psychology and Psychiatry*. Wiley. **42** (2): 241–251. doi:10.1111/1469-7610.00715. PMID 11280420. Pdf.

117. ^ *a b* Woolley, Anita Williams; Chabris, Christopher F.; Pentland, Alex; Hashmi, Nada; Malone, Thomas W. (2010-10-29). "Evidence for a Collective Intelligence Factor in the Performance of Human Groups". *Science*. **330** (6004): 686–688. Bibcode: 2010Sci...330..686W. doi:10.1126/science.1193147. PMID 20929725.
118. ^ Engel, David; Woolley, Anita Williams; Jing, Lisa X.; Chabris, Christopher F.; Malone, Thomas W. (2014-12-16). "Reading the Mind in the Eyes or Reading between the Lines? Theory of Mind Predicts Collective Intelligence Equally Well Online and Face-To-Face". *PLoS ONE*. **9** (12): e115212. Bibcode: 2014PLoSO...9k5212E. doi:10.1371/journal.pone.0115212. PMC 4267836 . PMID 25514387.
119. ^ Hallerbäck, Maria Unenge; Lugnegård, Tove; Hjärthag, Fredrik; Gillberg, Christopher (2009). "The Reading the Mind in the Eyes Test: test-retest reliability of a Swedish version". *Cognitive Neuropsychiatry*. Taylor and Francis. **14** (2): 127–143. doi:10.1080/13546800902901518. PMID 19370436.
120. ^ Pinkham, Amy E.; Penn, David L.; Green, Michael F.; Buck, Benjamin; Healey, Kristin; Harvey, Philip D. (2014-07-01). "The Social Cognition Psychometric Evaluation Study: Results of the Expert Survey and RAND Panel". *Schizophrenia Bulletin*. **40** (4): 813–823. doi:10.1093/schbul/sbt081. PMC 4059426 . PMID 23728248.
121. ^ Tsoukalas, Ioannis (2017). "Theory of Mind: Towards an Evolutionary Theory". *Evolutionary Psychological Science*: 1–29. doi:10.1007/s40806-017-0112-x. Pdf.
122. ^ Ristau, Carolyn A. (1991). "Aspects of the cognitive ethology of an injury-feigning bird, the piping plovers". In Ristau, Carolyn A. *Cognitive Ethology: Essays in Honor of Donald R. Griffin*. Hillsdale, New Jersey: Lawrence Erlbaum. pp. 91–126. ISBN 978-1-134-99085-6.
123. ^ Horowitz, Alexandra (2008). "Attention to attention in domestic dog (Canis familiaris) dyadic play". *Animal Cognition*. **12** (1): 107–18. doi:10.1007/s10071-008-0175-y. PMID 18679727.
124. ^ Povinelli, Daniel J.; Vonk, Jennifer (2003). "Chimpanzee minds: Suspiciously human?". *Trends in Cognitive Sciences*. **7** (4): 157–160. doi:10.1016/S1364-6613(03)00053-6. PMID 12691763.
125. ^ Povinelli, D.J.; Nelson, K.E.; Boysen, S.T. (1990). "Inferences about guessing and knowing by chimpanzees (*Pan troglodytes*)". *Journal of Comparative Psychology*. **104** (3): 203–210. doi:10.1037/0735-7036.104.3.203. PMID 2225758.
126. ^ Hare, B.; Call, J.; Tomasello, M. (2001). "Do chimpanzees know what conspecifics know and

do not know?". *Animal Behaviour*. **61** (1): 139–151. doi:10.1006/anbe.2000.1518. PMID 11170704.

127. ^ Hamilton, Jon (8 July 2006). "A Voluble Visit with Two Talking Apes". *NPR*. Retrieved 21 March 2012.
128. ^ Thomas Bugnyar; Stephan A. Reber & Cameron Buckner (2015). "Ravens attribute visual access to unseen competitors". *Nature Communications*. **7**: 10506. Bibcode: 2016NatCo...710506B. doi:10.1038/ncomms10506. PMC 4740864 . PMID 26835849.
129. ^ Christopher Krupenye; Fumihiro Kano; Satoshi Hirata; Josep Call; Michael Tomasello (2016). "Great apes anticipate that other individuals will act according to false beliefs". *Science*. **354** (6308): 110–114. doi:10.1126/science.aaf8110. PMID 27846501.

Further reading

- Excerpts taken from: Davis, E. (2007) Mental Verbs in Nicaraguan Sign Language and the Role of Language in Theory of Mind. Undergraduate senior thesis, Barnard College, Columbia University.

TOC | Previous

External links

- The Computational Theory of Mind
- The Identity Theory of Mind
- Sally-Anne and Smarties tests
- Functional Contextualism
- Theory of Mind article in the *Internet Encyclopedia of Philosophy*

Categories: Cognitive science | Theory of mind

Back to main TOC

Contents

Metacognition

Jump to navigation Jump to search

Metacognition is "cognition about cognition", " thinking about thinking", " knowing about knowing", becoming "aware of one's awareness" and higher-order thinking skills. The term comes from the root word *meta*, meaning "beyond".[1] Metacognition can take many forms; it includes knowledge about when and how to use particular strategies for learning or for problem-solving.[1] There are generally two components of metacognition: (1) knowledge about cognition and (2) regulation of cognition.[2]

Metamemory, defined as knowing about memory and mnemonic strategies, is an especially important form of metacognition.[3] Academic research on metacognitive processing across cultures is in the early stages, but there are indications that further work may provide better outcomes in cross-cultural learning between teachers and students.[4]

Some evolutionary psychologists hypothesize that humans use metacognition as a survival tool, which would make metacognition the same across cultures.[4][*need quotation to verify*] Writings on metacognition date back at least as far as two works by the Greek philosopher Aristotle (384-322 BC): *On the Soul* and the *Parva Naturalia*.[5]

TOP

TOC Next

Definitions

This higher-level cognition was given the label metacognition by American developmental psychologist John H. Flavell (1976).

The term metacognition literally means cognition about cognition, or more informally, thinking about thinking. Flavell defined metacognition as knowledge about cognition and control of cognition. For example, a person is engaging in metacognition if he notices that he is having more trouble learning A than B, or if it strikes her that she should double-check C before accepting it as fact. J. H. Flavell (1976, p. 232). Andreas Demetriou's theory (one of the neo-Piagetian theories of cognitive development) used the term hypercognition to refer to self-monitoring, self-representation, and self-regulation processes, which are regarded as integral components of the human mind.[6] Moreover, with his colleagues, he showed that these processes participate in general intelligence, together with processing efficiency and reasoning, which have traditionally been considered to compose fluid intelligence.[7]

Metacognition also involves thinking about one's own thinking process such as study skills, memory capabilities, and the ability to monitor learning. This concept needs to be explicitly taught along with content instruction. Metacognitive knowledge is about one's own cognitive processes and the understanding of how to regulate those processes to maximize learning.

Some types of metacognitive knowledge would include:

- Content knowledge (declarative knowledge) which is understanding one's own capabilities, such as a student evaluating his/her own knowledge of a subject in a class. It is notable that not all metacognition is accurate. Studies have shown that students often mistake lack of effort with understanding in evaluating themselves and their overall knowledge of a concept.[8] Also, greater confidence in having performed well is associated with less accurate metacognitive judgment of the performance.[9]

- Task knowledge (procedural knowledge), which is how one perceives the difficulty of a task which is the content, length, and the type of assignment. The study mentioned in Content knowledge also deals with a person's ability to evaluate the difficulty of a task related to their overall performance on the task. Again, the accuracy of this knowledge was skewed as students who thought their way was better/easier also seemed to perform worse on evaluations, while students who were rigorously and continually evaluated reported to not be as confident but still did better on initial evaluations.
- Strategic knowledge (conditional knowledge) which is one's own capability for using strategies to learn information. Young children are not particularly good at this; it is not until students are in upper elementary school that they begin to develop an understanding of effective strategies.

Metacognition is a general term encompassing the study of memory-monitoring and self-regulation, meta-reasoning, consciousness/ awareness and auto-consciousness/ self-awareness. In practice these capacities are used to regulate one's own cognition, to maximize one's potential to think, learn and to the evaluation of proper ethical/moral rules. It can also lead to a reduction in response time for a given situation as a result of heightened awareness, and potentially reduce the time to complete problems or tasks.

In the domain of experimental psychology, an influential distinction in metacognition (proposed by T. O. Nelson & L. Narens) is between Monitoring—making judgments about the strength of one's memories—and Control—using those judgments to guide behavior (in particular, to guide study choices). Dunlosky, Serra, and Baker (2007) covered this distinction in a review of metamemory research that focused on how findings from this domain can be applied to other areas of applied research.

In the domain of cognitive neuroscience, metacognitive monitoring and control has been viewed as a function of the prefrontal cortex, which receives (monitors) sensory signals from other cortical regions and implements control using feedback loops(see chapters by Schwartz & Bacon and Shimamura, in Dunlosky & Bjork, 2008).[3]

Metacognition is studied in the domain of artificial intelligence and modelling.[10] Therefore, it is the domain of interest of emergent systemics.

It has been used, albeit off the original definition, to describe one's own knowledge that we will die. Writers in the 1990s involved with the grunge music scene often used the term to describe self-awareness of mortality.[*citation needed*]

TOC Previous Next

Components

Metacognition is classified into three components:[11]

1. *Metacognitive knowledge* (also called metacognitive awareness) is what individuals know about themselves and others as cognitive processors.
2. *Metacognitive regulation* is the regulation of cognition and learning experiences through a set of activities that help people control their learning.
3. *Metacognitive experiences* are those experiences that have something to do with the current, on-going cognitive endeavor.

Metacognition refers to a level of thinking that involves active control over the process of thinking that is used in learning situations. Planning the way to approach a learning task, monitoring comprehension, and evaluating the progress towards the completion of a task: these are skills that are metacognitive in their nature.

Metacognition includes at least three different types of metacognitive awareness when considering metacognitive knowledge:[12]

1. **Declarative knowledge**: refers to knowledge about oneself as a learner and about what factors can influence one's performance.[2] Declarative knowledge can also be referred to as "world knowledge".[13]
2. **Procedural knowledge**: refers to knowledge about doing things. This type of knowledge is displayed as heuristics and strategies.[2] A high degree of procedural knowledge can allow individuals to perform tasks more automatically. This is achieved through a large variety of strategies that can be accessed more efficiently.[14]
3. **Conditional knowledge**: refers to knowing when and why to use declarative and procedural knowledge.[15] It allows students to allocate their resources when using strategies. This in turn allows the strategies to become more effective.[16]

Similar to metacognitive knowledge, metacognitive regulation or "regulation of cognition" contains three skills that are essential.[2][17]

1. **Planning**: refers to the appropriate selection of strategies and the correct allocation of resources that affect task performance.
2. **Monitoring**: refers to one's awareness of comprehension and task performance
3. **Evaluating**: refers to appraising the final product of a task and the efficiency at which the task was performed. This can include re-evaluating strategies that were used.

Similarly, maintaining motivation to see a task to completion is also a metacognitive skill. The ability to become aware of distracting stimuli – both internal and external – and sustain effort over time also involves metacognitive or executive functions. The theory that metacognition has a critical role to play in successful learning means it is important that it be demonstrated by both students and teachers.

Students who demonstrate a wide range of metacognitive skills perform better on exams and complete work more efficiently[*citation needed*]. They are self-regulated learners who utilize the "right tool for the job" and modify learning strategies and skills based on their awareness of effectiveness. Individuals with a high level of metacognitive knowledge and skill identify blocks to learning as early as possible and change "tools" or strategies to ensure goal attainment. Swanson (1990) found that metacognitive knowledge can compensate for IQ and lack of prior knowledge when comparing fifth and sixth grade students' problem solving. Students with a high-metacognition were reported to have used fewer strategies, but solved problems more effectively than low-metacognition students, regardless of IQ or prior knowledge.[18] In one study examining students who send text messages during college lectures, it was suggested that students with higher metacognitive abilities were less likely than other students to have their learning affected by using a mobile phone in class.[19]

Metacognologists are aware of their own strengths and weaknesses, the nature of the task at hand, and available "tools" or skills. A broader

repertoire of "tools" also assists in goal attainment. When "tools" are general, generic, and context independent, they are more likely to be useful in different types of learning situations.

Another distinction in metacognition is executive management and strategic knowledge. Executive management processes involve planning, monitoring, evaluating and revising one's own thinking processes and products. Strategic knowledge involves knowing *what* (factual or declarative knowledge), knowing *when and why* (conditional or contextual knowledge) and knowing *how* (procedural or methodological knowledge). Both executive management and strategic knowledge metacognition are needed to self-regulate one's own thinking and learning.[20]

Finally, there is no distinction between domain-general and domain-specific metacognitive skills. This means that metacognitive skills are domain-general in nature and there are no specific skills for certain subject areas. The metacognitive skills that are used to review an essay are the same as those that are used to verify an answer to a math question.[21]

Metacognitive experience is responsible for creating an identity that matters to an individual. The creation of the identity with metacognitive experience is linked to the identity-based motivation (IBM) model. The identity-based motivation model implies that "identities matter because they provide a basis for meaning making and for action."[22] A person decides also if the identity matters in two ways with metacognitive experience. First, a current or possible identity is either "part of the self and so worth pursuing"[23] or the individual thinks that the identity is part of their self, yet it is conflicting with more important identities and the individual will decide if the identity is or is not worth pursuing. Second, it also helps an individual decide if an identity should be pursued or abandoned.

Usually, abandoning identity has been linked to metacognitive difficulty. Based on the identity-based motivation model there are naive theories describing difficulty as a way to continue to pursue an identity. The incremental theory of ability states that if "effort matters then difficulty is likely to be interpreted as meaning that more effort is needed."[24] Here is

an example: a woman who loves to play clarinet has come upon a hard piece of music. She knows that how much effort she puts into learning this piece is beneficial. The piece had difficulty so she knew the effort was needed. The identity the woman wants to pursue is to be a good clarinet player; having a metacognitive experience difficulty pushed her to learn the difficult piece to continue to identify with her identity. The entity theory of ability represents the opposite. This theory states that if "effort does not matter then difficulty is likely to be interpreted as meaning that ability is lacking so effort should be suspended."[24] Based on the example of the woman playing the clarinet, if she did not want to identify herself as a good clarinet player, she would not have put in any effort to learn the difficult piece which is an example of using metacognitive experience difficulty to abandon an identity.[25]

Relation to sapience

Metacognologists believe that the ability to consciously think about thinking is unique to sapient species and indeed is one of the definitions of sapience.[citation needed] There is evidence that rhesus monkeys, apes, and dolphins can make accurate judgments about the strengths of their memories of fact and monitor their own uncertainty,[26] while attempts to demonstrate metacognition in birds have been inconclusive.[27] A 2007 study has provided some evidence for metacognition in rats,[28][29] but further analysis suggested that they may have been following simple operant conditioning principles,[30] or a behavioral economic model.[31]

TOC | Previous | Next

Strategies

Metacognitive-like processes are especially ubiquitous when it comes to the discussion of self-regulated learning. Being engaged in metacognition is a salient feature of good self-regulated learners.[citation needed] Reinforcing collective discussion of metacognition is a salient feature of self-critical and self-regulating social groups.[citation needed] The activities of strategy selection and application include those concerned with an ongoing attempt to plan, check, monitor, select, revise, evaluate, etc.

Metacognition is 'stable' in that learners' initial decisions derive from the pertinent facts about their cognition through years of learning experience. Simultaneously, it is also 'situated' in the sense that it depends on learners' familiarity with the task, motivation, emotion, and so forth. Individuals need to regulate their thoughts about the strategy they are using and adjust it based on the situation to which the strategy is being applied. At a professional level, this has led to emphasis on the development of reflective practice, particularly in the education and health-care professions.

Recently, the notion has been applied to the study of second language learners in the field of TESOL and applied linguistics in general (e.g., Wenden, 1987; Zhang, 2001, 2010). This new development has been much related to Flavell (1979), where the notion of metacognition is elaborated within a tripartite theoretical framework. Learner metacognition is defined and investigated by examining their person knowledge, task knowledge and strategy knowledge.

Wenden (1991) has proposed and used this framework and Zhang (2001) has adopted this approach and investigated second language learners' metacognition or metacognitive knowledge. In addition to exploring the relationships between learner metacognition and performance, researchers are also interested in the effects of metacognitively-oriented strategic instruction on reading comprehension (e.g., Garner, 1994, in first language contexts, and Chamot, 2005; Zhang, 2010). The efforts are aimed at

developing learner autonomy, interdependence and self-regulation.

Metacognition helps people to perform many cognitive tasks more effectively.[1] Strategies for promoting metacognition include self-questioning (e.g. "What do I already know about this topic? How have I solved problems like this before?"), thinking aloud while performing a task, and making graphic representations (e.g. concept maps, flow charts, semantic webs) of one's thoughts and knowledge. Carr, 2002, argues that the physical act of writing plays a large part in the development of metacognitive skills.[32]

Strategy Evaluation matrices (SEM) can help to improve the *knowledge of cognition* component of metacognition. The SEM works by identifying the declarative (Column 1), procedural (Column 2) and conditional (Column 3 and 4) knowledge about specific strategies. The SEM can help individuals identify the strength and weaknesses about certain strategies as well as introduce them to new strategies that they can add to their repertoire.[33]

A regulation checklist (RC) is a useful strategy for improving the regulation of cognition aspect of one's metacognition. RCs help individuals to implement a sequence of thoughts that allow them to go over their own metacognition.[33] King (1991) found that fifth-grade students who used a regulation checklist outperformed control students when looking at a variety of questions including written problem solving, asking strategic questions, and elaborating information.[34]

Examples of strategies that can be taught to students are word analysis skills, active reading strategies, listening skills, organizational skills and creating mnemonic devices.[35]

Walker and Walker have developed a model of metacognition in school learning termed Steering Cognition. Steering Cognition describes the capacity of the mind to exert conscious control over its reasoning and processing strategies in relation to the external learning task. Studies have shown that pupils with an ability to exert metacognitive regulation over their attentional and reasoning strategies used when engaged in maths, and then shift those strategies when engaged in science or then English

literature learning, associate with higher academic outcomes at secondary school.

Metastrategic knowledge

"Metastrategic knowledge" (MSK) is a sub-component of metacognition that is defined as general knowledge about higher order thinking strategies. MSK had been defined as "general knowledge about the cognitive procedures that are being manipulated". The knowledge involved in MSK consists of "making generalizations and drawing rules regarding a thinking strategy" and of "naming" the thinking strategy.[36]

The important conscious act of a metastrategic strategy is the "conscious" awareness that one is performing a form of higher order thinking. MSK is an awareness of the type of thinking strategies being used in specific instances and it consists of the following abilities: making generalizations and drawing rules regarding a thinking strategy, naming the thinking strategy, explaining when, why and how such a thinking strategy should be used, when it should not be used, what are the disadvantages of not using appropriate strategies, and what task characteristics call for the use of the strategy.[37]

MSK deals with the broader picture of the conceptual problem. It creates rules to describe and understand the physical world around the people who utilize these processes called higher-order thinking. This is the capability of the individual to take apart complex problems in order to understand the components in problem. These are the building blocks to understanding the "big picture" (of the main problem) through reflection and problem solving.[38]

Characteristics of theory of mind: Understanding the mind and the "mental world":

1. False beliefs: understanding that a belief is only one of many and can be false.
2. Appearance–reality distinctions: something may look one way but may be something else.
3. Visual perspective taking: the views of physical objects differ based on perspective.

4. Introspection: children's awareness and understanding of their own thoughts.

Action

Both social and cognitive dimensions of sporting expertise can be adequately explained from a metacognitive perspective according to recent research. The potential of metacognitive inferences and domain-general skills including psychological skills training are integral to the genesis of expert performance. Moreover, the contribution of both mental imagery (e.g., mental practice) and attentional strategies (e.g., routines) to our understanding of expertise and metacognition is noteworthy.[39] The potential of metacognition to illuminate our understanding of action was first highlighted by Aidan Moran who discussed the role of meta-attention in 1996.[40] A recent research initiative, a research seminar series called META funded by the BPS, is exploring the role of the related constructs of meta-motivation, meta-emotion, and thinking and action (metacognition).

TOC | Previous | Next

Mental illness

Sparks of interest

In the context of mental health, metacognition can be loosely defined as the process that "reinforces one's subjective sense of being a self and allows for becoming aware that some of one's thoughts and feelings are symptoms of an illness".[41] The interest in metacognition emerged from a concern for an individual's ability to understand their own mental status compared to others as well as the ability to cope with the source of their distress.[42] These insights into an individual's mental health status can have a profound effect on the over-all prognosis and recovery. Metacognition brings many unique insights into the normal daily functioning of a human being. It also demonstrates that a lack of these insights compromises 'normal' functioning. This leads to less healthy functioning. In the autism spectrum, there is a profound deficit in Theory of Mind.[43] In people who identify as alcoholics, there is a belief that the need to control cognitions is an independent predictor of alcohol use over anxiety. Alcohol may be used as a coping strategy for controlling unwanted thoughts and emotions formed by negative perceptions.[44] This is sometimes referred to as self medication.

TOC Previous Next

Implications

Wells' and Matthews'[45] theory proposes that when faced with an undesired choice, an individual can operate in two distinct modes: "object" and "metacognitive". Object mode interprets perceived stimuli as truth, where metacognitive mode understands thoughts as cues that have to be weighted and evaluated. They are not as easily trusted. There are targeted interventions unique of each patient, that gives rise to the belief that assistance in increasing metacognition in people diagnosed with schizophrenia is possible through tailored psychotherapy. With a

customized therapy in place clients then have the potential to develop greater ability to engage in complex self-reflection.[46] This can ultimately be pivotal in the patient's recovery process. In the obsessive–compulsive spectrum, cognitive formulations have greater attention to intrusive thoughts related to the disorder. "Cognitive self-consciousness" are the tendencies to focus attention on thought. Patients with OCD exemplify varying degrees of these "intrusive thoughts". Patients also suffering from generalized anxiety disorder also show negative thought process in their cognition.[47]

Cognitive-attentional syndrome (CAS) characterizes a metacognitive model of emotion disorder (CAS is consistent with the attention strategy of excessively focusing on the source of a threat). This ultimately develops through the client's own beliefs. Metacognitive therapy attempts to correct this change in the CAS. One of the techniques in this model is called attention training (ATT).[48] It was designed to diminish the worry and anxiety by a sense of control and cognitive awareness. ATT also trains clients to detect threats and test how controllable reality appears to be.[49]

Works of art as metacognitive artifacts

The concept of metacognition has also been applied to reader-response criticism. Narrative works of art, including novels, movies and musical compositions, can be characterized as metacognitive artifacts which are designed by the artist to anticipate and regulate the beliefs and cognitive processes of the recipient,[50] for instance, how and in which order events and their causes and identities are revealed to the reader of a detective story. As Menakhem Perry has pointed out, mere order has profound effects on the aesthetical meaning of a text.[51] Narrative works of art contain a representation of their own ideal reception process. They are something of a tool with which the creators of the work wish to attain certain aesthetical and even moral effects.[52]

TOC | Previous | Next

Mind wandering

There is an intimate, dynamic interplay between mind wandering and metacognition. Metacognition serves to correct the wandering mind, suppressing spontaneous thoughts and bringing attention back to more "worthwhile" tasks.[53][54]

TOC Previous Next

Organizational metacognition

The concept of metacognition has also been applied to collective teams and organizations in general, termed organizational metacognition.

- Educational psychology
- Educational technology
- Epistemology
- Goal orientation
- Introspection
- Learning styles
- Metacomprehension
- Meta-emotion
- Metaknowledge
- Metaphilosophy
- Münchhausen trilemma
- Metatheory
- Mentalization
- Mindstream
- Mirror test
- Phenomenology (philosophy)
- Phenomenology (psychology)
- Psychological effects of Internet use
- Second-order cybernetics

References

1. ^ *a* *b* *c* Metcalfe, J., & Shimamura, A. P. (1994). *Metacognition: knowing about knowing*. Cambridge, MA: MIT Press.
2. ^ *a* *b* *c* *d* *Schraw, Gregory (1998). "Promoting general metacognitive awareness". Instructional Science.* ***26****: 113–125. doi:10.1023/A:1003044231033.*
3. ^ *a* *b* Dunlosky, J. & Bjork, R. A. (Eds.). *Handbook of Metamemory and Memory*. Psychology Press: New York.
4. ^ *a* *b* Wright, Frederick. APERA Conference 2008. 14 April 2009. http://www.apera08.nie.edu.sg/proceedings/4.24.pdf [*dead link*]
5. ^ *Colman, Andrew M. (2015) [2001]. "metacognition". A Dictionary of Psychology. Oxford Paperback Reference (4 ed.). Oxford: Oxford University Press. p. 456. ISBN 9780199657681. Retrieved 2017-05-17. "Writings on metacognition can be traced back at least as far as De Anima and the Parva Naturalia of the Greek philosopher Aristotle (384-322 BC) [...]."*
6. ^ Demetriou, A., Efklides, A., & Platsidou, M. (1993). The architecture and dynamics of developing mind: Experiential structuralism as a frame for unifying cognitive developmental theories. *Monographs of the Society for Research in Child Development*, *58*, Serial Number 234.
7. ^ *Demetriou, A.; Kazi, S. (2006). "Self-awareness in g (with processing efficiency and reasoning)". Intelligence.* ***34*** *(3): 297–317. doi:10.1016/j.intell.2005.10.002.*
8. ^ *Lai, Emily (April 2011). "Metacognition: A Literature Review" (PDF). Metacognition: A Literature Review PDF. Retrieved April 23, 2016.*
9. ^ *Molenberghs, Pascal; Trautwein, Fynn-Mathis; Böckler, Anne; Singer, Tania; Kanske, Philipp (2016-12-01). "Neural correlates of metacognitive ability and of feeling confident: a large-scale fMRI study". Social Cognitive and Affective Neuroscience.* ***11*** *(12): 1942–1951. doi:10.1093/scan/nsw093. ISSN 1749-5024. PMC 5141950 . PMID 27445213.*
10. ^ *"Metacognition in computation: A selected research review".*

Artificial Intelligence. ***169***: 104–141. doi:10.1016/j.artint.2005.10.009.

11. ^ *Flavell, J.H. (1979). "Metacognition and cognitive monitoring. A new area of cognitive-development inquiry". American Psychologist.* ***34*** *(10): 906–911. doi:10.1037/0003-066X.34.10.906.*
12. ^ *Jacobs, J.E.; Paris, S.G. (1987). "Children's metacognition about reading: Issues in definition, measurement, and instruction". Educational Psychologist.* ***22***: *225–278.*
13. ^ *Schneider, W; Artelt, C. (2010). "Metacognition and mathematics education". ZDM Mathematics Education.* ***42*** *(2): 149–161. doi:10.1007/s11858-010-0240-2.*
14. ^ *Pressley, M; Borkowski, J.G.; Schneider, W. (1987). "Cognitive strategies: Good strategy users coordinate metacognition and knowledge". Annals of Child Development.* ***5***.
15. ^ *Garner, R (1990). "When children and adults do not use learning strategies: Toward a theory of settings". Review of Educational Research.* ***60*** *(4): 517–529. doi:10.3102/00346543060004517.*
16. ^ *Reynolds, R.E. (1992). "Selective attention and prose learning: Theoretical and empirical research". Educational Psychology Review.* ***4*** *(4): 345–391. doi:10.1007/BF01332144.*
17. ^ *Jacobs, J.E.; Paris, S.G. (1987). "Children's metacognition about reading: Issues in definition, measurement, and instruction". Educational Psychologist.* ***22***: *255–278. doi:10.1080/00461520.1987.9653052.*
18. ^ *Swanson, H.L. (1990). "Influence of metacognitive knowledge and aptitude on problem solving". Journal of Educational Psychology.* ***82*** *(2): 306–314. doi:10.1037/0022-0663.82.2.306.*
19. ^ Rosen, L. D., Lim, A. F., Carrier, L. M., & Cheever, N. A. (2011). An empirical examination of the educational impact of message-induced task switching in the classroom: Educational implications and strategies to enhance learning. Psicología Educativa, 17(2), 163-177.
20. ^ Hartman, 2001.
21. ^ *Gourgey, A.F. (1998). "Metacognition in basic skills instruction". Instructional science.* ***26***: *81–96. doi:10.1023/A:1003092414893.*
22. ^ Oyserman & Destin 1011, 2010.
23. ^ Oyserman & Destin 1013, 2010.
24. ^ ***a*** ***b*** Oyserman & Destin 1014, 2010.

25. ^ *Oyserman, D.; Destin, M. (2010). "Identity-Based Motivation: Implications for Intervention". The Counseling Psychologist.* ***38*** *(7): 1001–1043. doi:10.1177/0011000010374775. PMC 3079278 .*
26. ^ *Couchman, Justin J.; Coutinho, M. V. C.; Beran, M. J.; Smith, J. D. (2010). "Beyond Stimulus Cues and Reinforcement Signals: A New Approach to Animal Metacognition" (PDF). Journal of Comparative Psychology.* ***124*** *(4): 356 –368. doi:10.1037/a0020129. PMC 2991470 . PMID 20836592.*
27. ^ *Metacognition: Known unknowns*. Issue 2582 of New Scientist magazine, subscribers only.
28. ^ Rats Capable Of Reflecting On Mental Processes
29. ^ *Foote, Allison L.; Crystal, J. D. (20 March 2007). "Metacognition in the Rat". Current Biology.* ***17*** *(6): 551–555. doi:10.1016/j.cub.2007.01.061. PMC 1861845 . PMID 17346969.*
30. ^ *Smith, J. David; Beran, M. J.; Couchman, J. J.; Coutinho, M. V. C. (2008). "The Comparative Study of Metacognition: Sharper Paradigms, Safer Inferences" (PDF). Psychonomic Bulletin & Review.* ***15*** *(4): 679–691. doi:10.3758/PBR.15.4.679.*
31. ^ *Jozefowiez, J.; Staddon, J. E. R.; Cerutti, D. T. (2009). "Metacognition in animals: how do we know that they know?" (PDF). Comparative Cognition & Behavior Reviews.* ***4****: 29–39. doi:10.3819/ccbr.2009.40003.*
32. ^ *Gammil, D. (2006). "Learning the Write Way". The Reading Teacher.* ***59*** *(8): 754–762. doi:10.1598/RT.59.8.3.*
33. ^ ***a*** ***b*** *Schraw, Gregory (1998). "Promoting general metacogntive awareness". Instructional Science.* ***26****: 113–125. doi:10.1023/A:1003044231033.*
34. ^ *King, A (1991). "Effects of training in strategic questioning on children's problem solving performance". Journal of Educational Psychology.* ***83*** *(3): 307–317. doi:10.1037/0022-0663.83.3.307.*
35. ^ *Thompson, L; Thompson, M. (1998). "Neurofeedback combined with training in metacognitive strategies: Effectiveness in students with ADD". Applied Psychophysiology and Biofeedback.* ***23*** *(4): 243–63. doi:10.1023/A:1022213731956. PMID 10457815.*
36. ^ Zohar, A., & Ben David, A. (2009). Paving a clear path in a thick forest: A conceptual analysis of a metacognitive component.

Metacognition And Learning, 4(3), 177-195. doi: 10.1007/s11409-009-9044-6

37. ^ Veenman, M. V. J. (2006). Metacognition: Definitions, constituents, and their intricate relation with cognition. Symposium organized by Marcel V. J. Veenman, Anat Zohar, and Anastasia Efklides for the 2nd conference of the EARLI SIG on Metacognition (SIG 16), Cambridge, UK, 19–21 July.
38. ^ Beer, N., & Moneta, G. B. (2012). Coping and perceived stress as a function of positive metacognitions and positive meta-emotions. Individual Differences Research, 10(2), 105–116.
39. ^ *MacIntyre, TE; Igou, ER; Campbell, MJ; Moran, AP; Matthews, J (2014). "Metacognition and action: a new pathway to understanding social and cognitive aspects of expertise in sport". Front. Psychol.* ***5****: 1155. doi:10.3389/fpsyg.2014.01155.*
40. ^ Moran A. P. (1996). The Psychology of Concentration in Sport Performers: A Cognitive Analysis. Hove, East Sussex: Psychology Press
41. ^ *Lysaker, P. H.; Dimaggio, G.; Buck, K. D.; Callaway, S. S.; Salvatore, G.; Carcione, A. & Stanghellini, G. (2011). "Poor insight in schizophrenia: Links between different forms of metacognition with awareness of symptoms, treatment needed, and consequences of illness". Comprehensive Psychiatry.* ***52*** *(3): 253–260. doi:10.1016/j.comppsych.2010.07.007. PMID 21497218.*
42. ^ *Semerari, A.; Carcione, A.; Dimaggio, G.; Falcone, M.; Nicol, G.; Procacci, M.; Alleva, G. (2003). "How to evaluate Metacognitive function in psychotherapy? The Metacognition Assessment Scale and its applications". Clinical Psychology & Psychotherapy.* ***10****: 238–261. doi:10.1002/cpp.362.*
43. ^ *Lysaker, P. H. & Dimaggio, G. (2011). "Metacognitive disturbances in people with severe mental illness: Theory, correlates with psychopathology and models of psychotherapy". Psychology And Psychotherapy: Theory, Research And Practice.* ***84*** *(1): 1–8. doi:10.1111/j.2044-8341.2010.02007.x. PMID 22903827.*
44. ^ *Spada, M. M.; Zandvoort, M.; Wells, A. (2007). "Metacognitions in problem drinkers". Cognitive Therapy And Research.* ***31*** *(5): 709–716. doi:10.1007/s10608-006-9066-1.*
45. ^ Wells, A. & Mathews, G. (1997). Attention and Emotion. A clinical

perspective. Hove, UK: Erlbaum.
46. ^ *Lysaker, P. H.; Buck, K. D.; Carcione, A.; Procacci, M.; Salvatore, G.; Nicolò, G.; Dimaggio, G. (2011). "Addressing metacognitive capacity for self-reflection in the psychotherapy for schizophrenia: A conceptual model of the key tasks and processes". Psychology And Psychotherapy: Theory, Research And Practice.* ***84*** *(1): 58–69. doi:10.1348/147608310X520436. PMID 22903831.*
47. ^ *Jacobi, D. M.; Calamari, J. E.; Woodard, J. L. (2006). "Obsessive-Compulsive Disorder Beliefs, Metacognitive Beliefs and Obsessional Symptoms: Relations between Parent Beliefs and Child Symptoms". Clinical Psychology & Psychotherapy.* ***13*** *(3): 153–162. doi:10.1002/cpp.485.*
48. ^ *Wells, A (1990). "Panic disorder in association with relaxation-induced anxiety: An attentional training approach to treatment". Behaviour Therapy.* ***21****: 273–280. doi:10.1016/s0005-7894(05)80330-2.*
49. ^ *Wells, A.; Fisher, P.; Myers, S.; Wheatley, J.; Patel, T.; Brewin, C. R. (2009). "Metacognitive therapy in recurrent and persistent depression: A multiple-baseline study of a new treatment". Cognitive Therapy And Research.* ***33*** *(3): 291–300. doi:10.1007/s10608-007-9178-2.*
50. ^ *Lång, Markus (1998). "Teksti metakognitiivisena artefaktina: Sanataiteen ja säveltaiteen ontologiaa" [Text as a Metacognitive Artifact: Literary and Musical Ontology]. Synteesi (in Finnish).* ***17*** *(4): 82–94. ISSN 0359-5242.*
Lång, Markus (2002). "Elokuva metakognitiivisena artefaktina: Reseptioesteettinen katsaus" [Film as a metacognitive artifact: Reader-response critical review]. Synteesi (in Finnish). ***21*** *(1): 59–65. ISSN 0359-5242.*
51. ^ *Perry, Menakhem (1979). "Literary Dynamics: How the Order of a Text Creates Its Meanings". Poetics Today.* ***1*** *(1–2): 35–64, 311–361. doi:10.2307/1772040. JSTOR 1772040.*
52. ^ Lång 1998, p. 88.
53. ^ *Kieran, C. R. Fox; Kalina Christoff (2014). "Metacognitive Facilitation of Spontaneous Thought Processes: When Metacognition Helps the Wandering Mind Find Its Way". The Cognitive Neuroscience of Metacognition: 293–319. doi:10.1007/978-3-642-*

45190-4_13.
54. ^ *"Mind-wandering and metacognition: variation between internal and external thought predicts improved error awareness"*. *Retrieved 9 May 2014.*

Further reading

- Annual Editions: *Educational Psychology*. Guilford: Dushkin Pub., 2002. Print.
- Barell, J. (1992), "Like an incredibly hard algebra problem: Teaching for metacognition" In A. L. Costa, J. A. Bellanca, & R. Fogarty (eds.) *If minds matter: A foreword to the future, Volume I* (pp. 257–266). Palatine, IL: IRI/Skylight Publishing, Inc.
- Beck, G. M. (1998) The Impact of a Prescriptive Curriculum on the Development of Higher Order Thinking Skills in Children, Unpublished MA dissertation, University of Leicester.
- Brown, A. (1987). Metacognition, executive control, self-control, and other mysterious mechanisms. In F. Weinert and R. Kluwe (Eds.), Metacognition, Motivation, and Understanding (pp. 65–116). Hillsdale, NJ: Erlbaum.
- Burke, K. (1999), "*The Mindful School: How to Assess Authentic Learning*" (3rd ed.), SkyLight Training and Publishing, USA. ISBN 1-57517-151-1
- Carr, S.C. (2002). "Assessing learning processes: Useful information for teachers and students". *Intervention in School and Clinic*. **37** (3): 156–162. doi: 10.1177/105345120203700304.
- Chamot, A. (2005). The Cognitive Academic Language Learning Approach (CALLA): An update. In P. Richard-Amato and M. Snow (eds), *Academic Success for English Language Learners* (pp. 87–101). White Plains, NY: Longman.
- Dunlosky, John & Metcalfe, Janet (2009). *Metacognition*. Los Angeles: SAGE. ISBN 978-1-4129-3972-0
- Fisher, Peter & Wells, Adrian (2009). *Metacognitive Therapy: Distinctive Features*. London: Routledge. ISBN 978-0-415-43499-7
- Flavell, J. H. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), The nature of intelligence (pp. 231–236). Hillsdale, NJ: Erlbaum
- Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist, v34 n10 p906-11 Oct 1979.
- Hartman, H. J. (2001). Metacognition in Learning and Instruction: Theory, Research and Practice. Dordrecht: Kluwer Academic Publishers
- Niemi, H. (2002). Active learning—a cultural change needed in teacher education and schools. Teaching and Teacher Education, 18, 763-780.
- Rasekh, Z., & Ranjbary, R. (2003). Metacognitive strategy training for vocabulary learning, TESL-EJ, 7(2), 1-18.
- Shimamura, A. P. (2000). "Toward a cognitive neuroscience of metacognition". *Consciousness and Cognition*. **9** (2 Pt 1): 313–323. doi: 10.1006/ccog.2000.0450. PMID 10924251.
- H. S. Terrace & J. Metcalfe (Eds.), *The Missing Link in Cognition: Origins of Self-Reflective*

Consciousness. New York: Oxford University Press.

- MacIntyre TE, Igou ER, Campbell MJ, Moran AP and Matthews J (2014) Metacognition and action: a new pathway to understanding social and cognitive aspects of expertise in sport. Front. Psychol. 5:1155 doi: 10.3389/fpsyg.2014.01155 PMC 4199257
- Metcalfe, J., & Shimamura, A. P. (1994). *Metacognition: knowing about knowing*. Cambridge, MA: MIT Press.
- Papaleontiou-Louca, Eleonora (2008). *Metacognition and Theory of Mind*. Newcastle: Cambridge Scholars Publishing. ISBN 978-1-84718-578-5
- Smith, J. D., Beran, M. J., Couchman, J. J., Coutinho, M. V. C., & Boomer, J. B. (2009). *Animal metacognition: Problems and prospects*, WWW, Comparative Cognition and Behavior Reviews, 4, 40–53.
- Wenden, A. L. (1987). "Metacognition: An expanded view on the cognitive abilities of L2 learners". *Language Learning*. **37** (4): 573–594. doi: 10.1111/j.1467-1770.1987.tb00585.x.
- Wenden, A. (1991). *Learner Strategies for Learner Autonomy*. London: Prentice Hall.
- Wells, A. (2009). Metacognitive therapy for Anxiety and Depression. New York: Guilford Press.
- Wells, A. (2000). Emotional Disorders and Metacognition: Innovative Cognitive Therapy. Chichester, UK: Wiley.
- Wells, A. & Mathews, G. (1994). Attention and Emotion: A Clinical Perspective. Hove, UK: Erlbaum.
- Zhang, L. J. (2001). Awareness in reading: EFL students' metacognitive knowledge of reading strategies in an input-poor environment. *Language Awareness*, WWW, 11 (4), 268-288.
- Zhang, L. J. (2010). A dynamic metacognitive systems account of Chinese university students' knowledge about EFL reading. *TESOL Quarterly*, WWW, 44 (2), 320-353.

External links

- The International Association for Metacognition broken link
- Metacognition in Learning Concepts
- Metacognition: An Overview by Jennifer A. Livingston (1997) at Buffalo.edu
- Metacognitive knowledge[*dead link*]
- Metacognition in Computation overview – links
- Developing Metacognition – ERIC Digest
- Workshops on Metacognition and Self-Regulated Learning in Educational Technology
- Meditation and Metacognition
- [1] An Interdisciplinary perspective on expertise under the META framework which includes meta-motivation, meta-emotion and thinking and action (metacognition).
- "How much do we think about thinking? Science of Meta-awareness and Mind-wandering.", 'Bridging the Gaps: A Portal for Curious Minds', 2015

Categories: Cognitive science | Educational technology | Educational psychology

This page was last edited on 13 June 2018, at 02:19.

Contents

Schema (psychology)

This article is about psychology. For other uses, see Schema (disambiguation).

In psychology and cognitive science, a **schema** (plural *schemata* or *schemas*) describes a pattern of thought or behavior that organizes categories of information and the relationships among them.[1] It can also be described as a mental structure of preconceived ideas, a framework representing some aspect of the world, or a system of organizing and perceiving new information.[2] Schemata influence attention and the absorption of new knowledge: people are more likely to notice things that fit into their schema, while re-interpreting contradictions to the schema as exceptions or distorting them to fit. Schemata have a tendency to remain unchanged, even in the face of contradictory information. Schemata can help in understanding the world and the rapidly changing environment.[3] People can organize new perceptions into schemata quickly as most situations do not require complex thought when using schema, since automatic thought is all that is required.[3]

People use schemata to organize current knowledge and provide a framework for future understanding. Examples of schemata include academic rubrics, social schemas, stereotypes, social roles, scripts, worldviews, and archetypes. In Piaget's theory of development, children construct a series of schemata, based on the interactions they experience, to help them understand the world.[4]

History

Before psychology separated from philosophy, the term "schema" was prominently discussed in philosophy by Immanuel Kant.[5]

Early developments of the idea in psychology emerged with the gestalt psychologists and Jean Piaget: the term "schema" was introduced by Piaget in 1923.[6] The concept was popularized in psychology and education through the work of the British psychologist Frederic Bartlett,[7] who drew on the term body schema used by neurologist Henry Head. It was expanded into schema theory by educational psychologist Richard C. Anderson.[8] Since then, other terms have been used to describe schema such as "frame", "scene" and "script".

TOC Previous Next

Schematic processing

Through the use of schemata, a heuristic technique to encode and retrieve memories, the majority of typical situations do not require much strenuous processing. People can quickly organize new perceptions into schemata and act without effort.[9]

However, schemata can influence and hamper the uptake of new information (proactive interference), such as when existing stereotypes, giving rise to limited or biased discourses and expectations (prejudices), lead an individual to "see" or "remember" something that has not happened because it is more believable in terms of his/her schema.[10] For example, if a well-dressed businessman draws a knife on a vagrant, the schemata of onlookers may (and often do) lead them to "remember" the vagrant pulling the knife. Such distortion of memory has been demonstrated. (See § Background research below.)

Schemata are interrelated and multiple conflicting schemata can be applied to the same information. Schemata are generally thought to have a level of activation, which can spread among related schemata. Which schema is selected can depend on factors such as current activation, accessibility, priming and emotion.

Accessibility is how easily a schema comes to mind, and is determined by personal experience and expertise. This can be used as a cognitive shortcut; it allows the most common explanation to be chosen for new information.

With priming, a brief imperceptible stimulus temporarily provides enough activation to a schema so that it is used for subsequent ambiguous information. Although this may suggest the possibility of subliminal messages, the effect of priming is so fleeting that it is difficult to detect outside laboratory conditions. Furthermore, the mere exposure effect—which requires consciousness of the stimuli—is far more effective than priming.

Background research

The original concept of schemata is linked with that of reconstructive memory as proposed and demonstrated in a series of experiments by Bartlett.[11] By presenting participants with information that was unfamiliar to their cultural backgrounds and expectations and then monitoring how they recalled these different items of information (stories, etc.), Bartlett was able to establish that individuals' existing schemata and stereotypes influence not only how they interpret "schema-foreign" new information but also how they recall the information over time. One of his most famous investigations involved asking participants to read a Native American folk tale, "The War of the Ghosts", and recall it several times up to a year later. All the participants transformed the details of the story in such a way that it reflected their cultural norms and expectations, i.e. in line with their schemata. The factors that influenced their recall were:

- Omission of information that was considered irrelevant to a participant;
- Transformation of some of the details, or of the order in which events, etc., were recalled; a shift of focus and emphasis in terms of what was considered the most important aspects of the tale;
- Rationalization: details and aspects of the tale that would not make sense would be "padded out" and explained in an attempt to render them comprehensible to the individual in question;
- Cultural shifts: the content and the style of the story were altered in order to appear more coherent and appropriate in terms of the cultural background of the participant.

Bartlett's work was crucially important in demonstrating that long-term memories are neither fixed nor immutable but are constantly being adjusted as schemata evolve with experience. In a sense it supports the existentialist view that people construct the past and present in a constant process of narrative/discursive adjustment, and that much of what people "remember" is actually confabulated (adjusted and rationalized) narrative that allows them to think of the past as a continuous and coherent string of events, even though it is probable that large sections of memory

(both episodic and semantic) are irretrievable at any given time.[11]

An important step in the development of schema theory was taken by the work of D.E. Rumelhart describing the understanding of narrative and stories.[12] Further work on the concept of schemata was conducted by W.F. Brewer and J.C. Treyens, who demonstrated that the schema-driven expectation of the presence of an object was sometimes sufficient to trigger its erroneous recollection.[13] An experiment was conducted where participants were requested to wait in a room identified as an academic's study and were later asked about the room's contents. A number of the participants recalled having seen books in the study whereas none were present. Brewer and Treyens concluded that the participants' expectations that books are present in academics' studies were enough to prevent their accurate recollection of the scenes.

In the 1970s, computer scientist Marvin Minsky was trying to develop machines that would have human-like abilities. When he was trying to create solutions for some of the difficulties he encountered he came across Bartlett's work and decided that if he was ever going to get machines to act like humans he needed them to use their stored knowledge to carry out processes. To compensate for that he created what was known as the frame construct, which was a way to represent knowledge in machines. His frame construct can be seen as an extension and elaboration of the schema construct. He created the frame knowledge concept as a way to interact with new information. He proposed that fixed and broad information would be represented as the frame, but it would also be composed of slots that would accept a range of values; but if the world didn't have a value for a slot, then it would be filled by a default value.[14] Because of Minsky's work, computers now have a stronger impact on psychology. In the 1980s, David Rumelhart extended Minsky's ideas, creating an explicitly psychological theory of the mental representation of complex knowledge.[15]

Roger Schank and Robert Abelson developed the idea of a script, which was known as a generic knowledge of sequences of actions. This led to many new empirical studies, which found that providing relevant schema can help improve comprehension and recall on passages.[16]

Modification

New information that falls within an individual's schema is easily remembered and incorporated into their worldview. However, when new information is perceived that does not fit a schema, many things can happen. The most common reaction is to simply ignore or quickly forget the new information.[17] This can happen on a deep level— frequently an individual does not become conscious of or even perceive the new information. People may also interpret the new information in a way that minimizes how much they must change their schemata. For example, Bob thinks that chickens don't lay eggs. He then sees a chicken laying an egg. Instead of changing the part of his schema that says "chickens don't lay eggs", he is likely to adopt the belief that the animal in question that he has just seen laying an egg is not a real chicken. This is an example of disconfirmation bias, the tendency to set higher standards for evidence that contradicts one's expectations.[18] However, when the new information cannot be ignored, existing schemata must be changed or new schemata must be created (accommodation).[19]

Jean Piaget (1896–1980) was known best for his work with development of human knowledge. He believed knowledge was constructed on cognitive structures, and he believed people develop cognitive structures by accommodating and assimilating information. Accommodation is creating new schema that will fit better with the new environment or adjusting old schema. Accommodation could also be interpreted as putting restrictions on a current schema. Accommodation usually comes about when assimilation has failed. Assimilation is when people use a current schema to understand the world around them. Piaget thought that schemata are applied to everyday life and therefore people accommodate and assimilate information naturally.[20] For example, if this chicken has red feathers, Bob can form a new schemata that says "chickens with red feathers can lay eggs". This schemata will then be either changed or removed, in the future.

Assimilation is the reuse of schemata to fit the new information. An

example would be, when an unfamiliar dog is seen, a person will probably just integrate it into their dog schema. However, if the dog behaves strangely, and in ways that doesn't seem dog-like, there will be accommodation as a new schema is formed for that particular dog. With Accommodation and Assimilation comes the idea of equilibrium. Piaget describes equilibrium as a state of cognition that is balanced when schema are capable of explaining what it sees and perceives. When information is new and cannot fit into existing schema this is called disequilibrium and this is an unpleasant state for the child's development. When disequilibrium happens, it means the person is frustrated and will try to restore the coherence of his or her cognitive structures through accommodation. If the new information is taken then assimilation of the new information will proceed until they find that they must make a new adjustment to it later down the road, but for now the child remains at equilibrium again. The process of equilibration is when people move from the equilibrium phase to the disequilibrium phase and back into equilibrium.[21]

TOC Previous Next

Self-schemata

Main article: Self-schema

Schemata about oneself are considered to be grounded in the present and based on past experiences. Memories are framed in the light of one's self-conception. For example, people who have positive self-schemata (i.e. most people) selectively attend to flattering information and selectively ignore unflattering information, with the consequence that flattering information is subject to deeper encoding, and therefore superior recall.[22] Even when encoding is equally strong for positive and negative feedback, positive feedback is more likely to be recalled.[23] Moreover, memories may even be distorted to become more favorable-people typically remember exam grades as having been better than they actually were.[24] However, when people have negative self views, memories are generally biased in ways that validate the negative self-schema; people with low self-esteem, for instance, are prone to remember more negative information about themselves than positive information.[25] Thus, memory tends to be biased in a way that validates the agent's pre-existing self-schema.

There are three major implications of self-schemata. First, information about oneself is processed faster and more efficiently, especially consistent information. Second, one retrieves and remembers information that is relevant to one's self-schema. Third, one will tend to resist information in the environment that is contradictory to one's self-schema. For instance, students with a particular self-schema prefer roommates whose view of them is consistent with that schema. Students who end up with roommates whose view of them is inconsistent with their self-schema are more likely to try to find a new roommate, even if this view is positive.[26] This is an example of self-verification.

As researched by Aaron Beck, automatically-activated negative self-schemata are a large contributor to depression. According to Cox, Abramson, Devine, and Hollon (2012), these self-schemata are essentially the same type of cognitive structure as stereotypes studied by

prejudice researchers (e.g., they are both well-rehearsed, automatically activated, difficult to change, influential toward behavior, emotions, and judgments, and bias information processing).[27]

The self-schema can also be self-perpetuating. It can represent a particular role in society that is based on stereotype, for example: "If a mother tells her daughter she looks like a tom boy, her daughter may react by choosing activities that she imagines a tom boy would do. Conversely, if the mother tells her she looks like a princess, her daughter might choose activities thought to be more feminine." This is an example of the self-schema becoming self-perpetuating when the person at hand chooses an activity that was based on an expectation rather than their desires.[28]

Schema therapy

Main articles: Schema therapy and List of maladaptive schemas

Schema therapy was founded by Jeffrey Young, and represents a development of cognitive behavioral therapy (CBT) specifically for treating personality disorders.[29][30] *Early maladaptive schemata* are described by Young as broad and pervasive themes or patterns made up of memories, feelings, sensations, and thoughts regarding oneself and one's relationships with others. They are considered to develop during childhood or adolescence, and to be dysfunctional in that they lead to self-defeating behavior. Examples include schemata of abandonment/instability, mistrust/abuse, emotional deprivation, and defectiveness/shame.[30]

Schema therapy blends CBT with elements of Gestalt therapy, object relations, constructivist and psychoanalytic therapies in order to treat the characterological difficulties which both constitute personality disorders and which underlie many of the chronic depressive or anxiety-involving symptoms which present in the clinic. Young said that CBT may be an effective treatment for presenting symptoms, but without the conceptual or clinical resources for tackling the underlying structures (maladaptive schemata) which consistently organize the patient's experience, the patient is likely to lapse back into unhelpful modes of relating to others and attempting to meet their needs. Young focused on pulling from different therapies equally when developing schema therapy. The difference between cognitive behavioral therapy and schema therapy is the latter "emphasizes lifelong patterns, affective change techniques, and the therapeutic relationship, with special emphasis on limited reparenting".[31] He recommended this therapy would be ideal for clients with difficult and chronic psychological disorders. Some examples would be eating disorders, personality disorders and criminal offenders. He has also had success with this therapy in relation to depression and substance abuse.[31]

See also

- Cultural schema theory
- Memetics
- Personal construct theory
- Relational frame theory
- Social cognition

References

1. ^ *DiMaggio, P (1997). "Culture and cognition". Annual Review of Sociology. **23**: 263–287. doi:10.1146/annurev.soc.23.1.263.*
2. ^ *"Glossary". Retrieved 7 March 2013.*
3. ^ a b *Nadkarni, S.; Narayanan, V. K. (2007). "Strategic schemas, strategic flexibility, and firm performance: The moderating role of industry clockspeed". Strategic Management Journal. **28** (3): 243–270. doi:10.1002/smj.576.*
4. ^ *Georgeon, O.R.; Ritter, F.E. (2011). "An intrinsically motivated schema mechanism to model and simulate emergent cognition". Cognitive Systems Research. 15–16: 75. doi:10.1016/j.cogsys.2011.07.003.*
5. ^ *Nevid, J. S. (2007). "Kant, cognitive psychotherapy, and the hardening of the categories". Psychology and Psychotherapy: Theory, Research and Practice. **80** (4): 605–615. doi:10.1348/147608307X204189.*
6. ^ Piaget, J. (1923). *"Langage et pensée chez l'enfant"* *(PDF)*. (3e éd. 1948 revue et avec un nouvel avant-propos et un nouveau chapitre II inséré utgave bind). Neuchâtel: Delachaux et Niestlé, p. 43f.
7. ^ *Bartlett, F.C. (1932). Remembering: A Study in Experimental and Social Psychology (PDF). Cambridge, England: Cambridge University Press.*
8. ^ *"Schema theory of learning". LinguaLinks Library. SIL International. 2 July 1998.*
9. ^ *Kleider, H. M.; Pezdek, K.; Goldinger, S. D.; Kirk, A. (2008). "Schema-driven source misattribution errors: Remembering the expected from a witnessed event". Applied Cognitive Psychology. **22** (1): 1–20. doi:10.1002/acp.1361.*
10. ^ *Tuckey, M.; Brewer, N. (2003). "The influence of schemas, stimulus ambiguity, and interview schedule on eyewitness memory over time". Journal of Experimental Psychology: Applied. **9** (2): 101–118. doi:10.1037/1076-898X.9.2.101.*
11. ^ a b Bartlett, F.C. (1932). Remembering: A study in experimental and social psychology. Cambridge, England: Cambridge University Press

12. ^ Rumelhart, D.E. (1980) Schemata: the building blocks of cognition. In: R.J. Spiro et al. (Eds) Theoretical Issues in Reading Comprehension, Hillsdale, NJ: Lawrence Erlbaum. See also: Mandler, J. M. (1984). Stories, scripts, and scenes: Aspects of schema theory. Hillsdale, NJ: Lawrence Erlbaum Associates.
13. ^ *Brewer, W. F.; Treyens, J. C. (1981). "Role of schemata in memory for places". Cognitive Psychology. **13** (2): 207–230. doi:10.1016/0010-0285(81)90008-6.*
14. ^ *Minsky, Marvin (1975). Patrick H. Winston, ed. A Framework for Representing Knowledge (The Psychology of Computer Vision ed.). New York: McGraw-Hill.*
15. ^ *Rumelhart, David E. (1980). Schemata: The Building Blocks of Cognition (Theoretical Issues in Reading Comprehension ed.). Hillsdale, NJ: Erlbaum.*
16. ^ *Schank, Rodger C.; Abelson, Robert P. (1977). Scripts, Plans, Goals and Understanding. Hillsdale, NJ: Erlbaum.*
17. ^ Taylor, S. E., & Crocker, J. (1981). Schematic bases of social information processing. In E. T. Higgins, C. A. Herman, & M. P. Zanna (Eds.), Social cognition: The Ontario Symposium on Personality and Social Psychology (pp. 89-134). Hillsdale, NJ: Erlbaum.
18. ^ *Taber, Charles S.; Lodge, Milton (2006). "Motivated Skepticism in the Evaluation of Political Beliefs". American Journal of Political Science. Midwest Political Science Association. **50** (3): 755–769. doi:10.1111/j.1540-5907.2006.00214.x. ISSN 0092-5853.*
19. ^ *O'Sullivan, Chris S.; Durso, Francis T. (1984). "Effect of schema-incongruent information on memory for stereotypical attributes". Journal of Personality and Social Psychology. **47** (1): 55–70. doi:10.1037/0022-3514.47.1.55. PMID 6747816.*
20. ^ *Piaget, Jean (2001). Robert L. Campbell, ed. Studies in Reflection Abstraction. Sussex: Psychology Press. ISBN 1-84169-157-7.*
21. ^ *McLeod, S. A (2009). "Jean Piaget | Cognitive Theory". Retrieved 25 February 2013.*
22. ^ *Sedikides, C.; Green, J. D. (2000). "On the self-protective nature of inconsistency/negativity management: Using the person memory paradigm to examine self-referent memory". Journal of Personality and Social Psychology. **79**: 906–92. doi:10.1037/0022-3514.79.6.906.*

PMID 11138760.
23. ^ *Sanitioso, R.; Kunda, Z.; Fong, G. T. (1990). "Motivated recruitment of autobiographical memories". Journal of Personality and Social Psychology.* ***59*** *(2): 229–41. doi:10.1037/0022-3514.59.2.229. PMID 2213492.*
24. ^ *Bahrick, Harry P; Hall, Lynda K; Berger, Stephanie A (1996). "Accuracy and Distortion in Memory for High School Grades". Psychological Science.* ***7*** *(5): 265–271. doi:10.1111/j.1467-9280.1996.tb00372.x.*
25. ^ *Story, A. L. (1998). "Self-esteem and memory for favorable and unfavorable personality feedback". Personality and Social Psychology Bulletin.* ***24****: 51–64. doi:10.1177/0146167298241004.*
26. ^ *Swann, W. B.; Jr; Pelham, B. W. (2002). "Who wants out when the going gets good? Psychological investment and preference for self-verifying college roommates". Journal of Self and Identity.* ***1****: 219–233. doi:10.1080/152988602760124856.*
27. ^ *Cox, William T. L.; Abramson, Lyn Y.; Devine, Patricia G.; Hollon, Steven D. (2012). "Stereotypes, Prejudice, and Depression: The Integrated Perspective". Perspectives on Psychological Science.* ***7*** *(5): 427–449. doi:10.1177/1745691612455204. PMID 26168502.*
28. ^ *"Psychology Glossary". Retrieved 7 March 2013.*
29. ^ Young, J. E. (1999) Cognitive therapy for personality disorders: A schema-focused approach. (rev ed.) Sarasota, FL: Professional Resources Press
30. ^ ***a*** ***b*** Young, Klosko & Weishaar (2003), Schema Therapy: A Practitioner's Guide. New York: The Guilford Press.
31. ^ ***a*** ***b*** *Young, Jeffery. "Schema Therapy". American Psychological Association. Retrieved 28 February 2013.*

External links

- Widmayer, Sharon Alayne (2002). "Schema Theory: An Introduction". *CiteSeerX*.
- Bucci, Wilma (2010). "Emotion Schemas". *thereferentialprocess.org*.

Categories: Cognitive science | Psychological adjustment | Psychological theories

Back to main TOC

Contents

Learning Curve

Jump to navigation Jump to search
For other uses, see Learning curve (disambiguation).

A **learning curve** is a graphical representation of how an increase in learning (measured on the vertical axis) comes from greater experience (the horizontal axis); or how the more someone (or thing) does something, the better they get at it.[1]

The term *learning curve* is used in two main ways: where the same task is repeated in a series of trials, or where a body of knowledge is learned over time. The first person to describe the learning curve was Hermann Ebbinghaus in 1885, in the field of the psychology of learning, although the name wasn't used until 1903.[2][3] In 1936, Theodore Paul Wright described the effect of learning on production costs in the aircraft industry.[4] This form, in which *unit cost* is plotted against *total production*, is sometimes called an experience curve.

The familiar expression "*a steep learning curve*" is intended to mean that the activity is difficult to learn, although a learning curve with a steep start actually represents rapid progress.[5][6]

TOP

TOC Next

In psychology

The first person to describe the learning curve was Hermann Ebbinghaus in 1885. His tests involved memorizing series of nonsense syllables, and recording the success over a number of trials. The translation does not use the term *learning curve*—but he presents diagrams of learning against trial number. He also notes that the score can decrease, or even oscillate.[6][7][8]

The first known use of the term *learning curve* is from 1903: "Bryan and Harter (6) found in their study of the acquisition of the telegraphic language a learning curve which had the rapid rise at the beginning followed by a period of retardation, and was thus convex to the vertical axis."[3][6]

Psychologist Arthur Bills gave a more detailed description of learning curves in 1934. He also discussed the properties of different types of learning curves, such as negative acceleration, positive acceleration, plateaus, and ogive curves. (Fig 1)[9]

In economics

In 1936, Theodore Paul Wright described the effect of learning on production costs in the aircraft industry and proposed a mathematical model of the learning curve.[4]

In 1968 Bruce Henderson of the Boston Consulting Group (BCG) generalized the Unit Cost model pioneered by Wright, and specifically used a Power Law, which is sometimes called *Henderson's Law*. He named this particular version the **experience curve**.[10][11] Research by BCG in the 1970s observed experience curve effects for various industries that ranged from 10 to 25 percent.[12]

The economic learning of productivity and efficiency generally follows the same kinds of experience curves and have interesting secondary effects. Efficiency and productivity improvement can be considered as whole organization or industry or economy learning processes, as well as for individuals. The general pattern is of first speeding up and then slowing down, as the practically achievable level of methodology improvement is reached. The effect of reducing local effort and resource use by learning improved methods paradoxically often has the opposite latent effect on the next larger scale system, by facilitating its expansion, or economic growth, as discussed in the Jevons paradox in the 1880s and updated in the Khazzoom-Brookes Postulate in the 1980s.

Examples and mathematical modeling

A learning curve is a plot of proxy measures for implied learning (proficiency or progression toward a limit) with experience.

- The *Horizontal Axis* represents *experience* either directly as time (clock time, or the time spent on the activity), or can be related to time (a number of trials, or the total number of units produced).
- The *Vertical Axis* is a measure representing *learning* or *proficiency* or other proxy for "efficiency" or "productivity". It can either be increasing (for example, the score in a test), or decreasing (the time to complete a test). (Fig 5)

For the performance of one person in a series of trials the curve can be erratic, with proficiency increasing, decreasing or leveling out in a plateau. (Fig 1)

When the results of a large number of individual trials are averaged then a smooth curve results, which can often be described with a mathematical function. (Fig 2)

Fig 3: S-Curve or Sigmoid Function

Fig 4: Exponential growth

Fig 5: Exponential rise or fall to a limit

Fig 6: Power Law

Several main functions have been used:[13][14][15]

- The S-Curve or Sigmoid function is the idealized general form of all learning curves, with slowly accumulating small steps at first followed by larger steps and then successively smaller ones later, as the learning activity reaches its limit. That idealizes the normal progression from discovery of something to learn about followed to the limit of what learning about it. The other shapes of learning curves

(4, 5 & 6) show segments of S-curves without their full extents.

In this case the improvement of proficiency starts slowly, then increases rapidly, and finally levels off. (Fig 3)

- Exponential growth

  The proficiency can increase without limit, as in Exponential growth (Fig 4)

- Exponential rise or fall to a Limit

  Proficiency can exponentially approach a limit in a manner similar to that in which a capacitor charges or discharges (Exponential decay) through a resistor. (Fig 5)

  The increase in skill or retention of information may increase rapidly to its maximum rate during the initial attempts, and then gradually levels out, meaning that the subject's skill does not improve much with each later repetition, with less new knowledge gained over time.

- Power law

  This is similar in appearance to an Exponential decay function, and is almost always used for a decreasing performance metric, such as cost. (Fig 6) It also has the property that if you plot the logarithm of proficiency against the logarithm of experience the result is a straight line, and it is often presented that way.

The specific case of a plot of Unit Cost versus Total Production with a Power Law was named the **Experience Curve**: the mathematical function is sometimes called *Henderson's Law*.

This form of learning curve is used extensively in industry for cost projections.[16]

The page on "Experience curve effects" offers more discussion of the mathematical theory of representing them as deterministic processes, and provides a good group of empirical examples of how that technique has been applied.

In machine learning

Plots relating performance to experience are widely used in machine learning. Performance is the error rate or accuracy of the learning system, while experience may be the number of training examples used for learning or the number of iterations used in optimizing the system model parameters.[17] The machine learning curve is useful for many purposes including comparing different algorithms,[18] choosing model parameters during design,[19] adjusting optimization to improve convergence, and determining the amount of data used for training.[20]

Broader interpretations

Initially introduced in educational and behavioral psychology, the term has acquired a broader interpretation over time, and expressions such as "experience curve", "improvement curve", "cost improvement curve", "progress curve", "progress function", "startup curve", and "efficiency curve" are often used interchangeably. In economics the subject is rates of " development", as development refers to a whole system learning process with varying rates of progression. Generally speaking all learning displays **incremental change** over time, but describes an **"S" curve** which has different appearances depending on the time scale of observation. It has now also become associated with the evolutionary theory of punctuated equilibrium and other kinds of **revolutionary change** in complex systems generally, relating to innovation, organizational behavior and the management of group learning, among other fields.[21] These processes of rapidly emerging new form appear to take place by complex learning within the systems themselves, which when observable, display curves of changing rates that accelerate and decelerate.

General learning limits

Learning curves, also called *experience curves*, relate to the much broader subject of natural limits for resources and technologies in general. Such limits generally present themselves as increasing complications that slow the learning of how to do things more efficiently, like the well-known limits of perfecting any process or product or to perfecting measurements.[22] These practical experiences match the predictions of the second law of thermodynamics for the limits of waste reduction generally. Approaching limits of perfecting things to eliminate waste meets geometrically increasing effort to make progress, and provides an environmental measure of all factors seen and unseen changing the learning experience. Perfecting things becomes ever more difficult despite increasing effort despite continuing positive, if ever diminishing, results. The same kind of slowing progress due to complications in learning also appears in the limits of useful technologies and of profitable markets applying to product life cycle management and software development cycles). Remaining market segments or remaining potential efficiencies or efficiencies are found in successively less convenient forms.

Efficiency and development curves typically follow a two-phase process of first bigger steps corresponding to finding things easier, followed by smaller steps of finding things more difficult. It reflects bursts of learning following breakthroughs that make learning easier followed by meeting constraints that make learning ever harder, perhaps toward a point of cessation.

- **Natural Limits** One of the key studies in the area concerns diminishing returns on investments generally, either physical or financial, pointing to whole system limits for resource development or other efforts. The most studied of these may be Energy Return on Energy Invested or EROEI, discussed at length in an Encyclopedia of the Earth article and in an OilDrum article and series also referred to as Hubert curves. The energy needed to produce energy is a measure of our difficulty in learning how to make remaining

energy resources useful in relation to the effort expended. Energy returns on energy invested have been in continual decline for some time, caused by natural resource limits and increasing investment. Energy is both nature's and our own principal resource for making things happen. The point of diminishing returns is when increasing investment makes the resource more expensive. As natural limits are approached, easily used sources are exhausted and ones with more complications need to be used instead. As an environmental signal persistently diminishing EROI indicates an approach of whole system limits in our ability to make things happen.

- **Useful Natural Limits** EROEI measures the return on invested effort as a ratio of R/I or *learning progress*. The inverse I/R measures *learning difficulty*. The simple difference is that if R approaches zero R/I will too, but I/R will approach infinity. When complications emerge to limit learning progress the limit of *useful returns*, uR, is approached and R-uR approaches zero. The *difficulty of useful learning* I/(R-uR) approaches infinity as increasingly difficult tasks make the effort unproductive. That point is approached as a vertical asymptote, at a particular point in time, that can be delayed only by unsustainable effort. It defines a point at which enough investment has been made and the *task is done*, usually planned to be the same as when the *task is complete*. For unplanned tasks it may be either foreseen or discovered by surprise. The usefulness measure, uR, is affected by the complexity of environmental responses that can only be measured when they occur unless they are foreseen.

In culture

"Steep learning curve"

The expression ***steep learning curve*** is used with opposite meanings. Most sources, including the *Oxford English Dictionary*, the *American Heritage Dictionary of the English Language*, and *Merriam-Webster's Collegiate Dictionary*, define a learning curve as the rate at which skill is acquired, so a steep increase would mean a quick increment of skill.[5][23] However, the term is often used in common English with the meaning of a difficult initial learning process.[6][23]

Arguably, the common English use is due to metaphorical interpretation of the curve as a hill to climb. (A steeper hill is initially hard, while a gentle slope is less strainful, though sometimes rather tedious. Accordingly, the shape of the curve (hill) may not indicate the total amount of work required. Instead, it can be understood as a matter of preference related to ambition, personality and learning style.)

Fig 9 : Short and long learning curves

Fig 10 : Product A has lower functionality and a short learning curve. Product B has greater functionality but takes longer to learn

The term *learning curve* with meanings of *easy* and *difficult* can be described with adjectives like *short* and *long* rather than *steep* and *shallow*.[5] If two products have similar functionality then the one with a "steep" curve is probably better, because it can be learned in a shorter time. (Fig 9) On the other hand, if two products have different functionality, then one with a *short* curve (a short time to learn) and limited functionality may not be as good as one with a *long* curve (a long time to learn) and greater functionality. (Fig 10)

For example, the Windows program Notepad is extremely simple to learn, but offers little after this. At the other extreme is the UNIX terminal editor vi or Vim, which is difficult to learn, but offers a wide array of features after the user has learned how to use it.[24]

TOC | Previous | Next

"ON a steep learning curve"

Ben Zimmer discusses the use of the term "ON a steep learning curve" in an article "A Steep Learning Curve" for *Downton Abbey*, concentrating mainly on whether it is an anachronism. "Matthew Crawley, the presumptive heir of Downton Abbey and now the co-owner of the estate, says, 'I've been on a steep learning curve since arriving at Downton.' By this he means that he's had a difficult time learning the ways

of Downton. Unfortunately, people didn't start talking that way until the 1970s."[6][25][26]

Zimmer also comments that the popular use of *steep* as *difficult* is a reversal of the technical meaning. He identifies the first use of *steep learning curve* as 1973, and the *arduous* interpretation as 1978.

TOC Previous Next

See also

- Experience curve effects
- Learning
- Learning speed
- Labor productivity
- Learning-by-doing
- Population growth
- Trial and error

References

1. ^ *"Learning Curve". Business Dictionary. Retrieved 4 January 2018.*
2. ^ https://books.google.com/books?id=oRSMDF6y3l8C&printsec=frontcover#v=onepage&q&f=false Page 42, Fig 2
3. ^ *a* *b* https://books.google.com/books?id=ikEMAAAAIAAJ&q=%22learning+curve%22#v=snippet&q=%22l The American Journal of Psychology, Volume 14 1903 By Granville Stanley Hall, Edward Bradford Titchene
4. ^ *a* *b* Wright, T.P., "Factors Affecting the Cost of Airplanes", *Journal of Aeronautical Sciences*, 3(4) (1936): 122–128.
5. ^ *a* *b* *c* "Laparoscopic Colon Resection Early in the Learning Curve", *Ann. Surg.* 2006 June; 243(6): 730–737, see the "Discussions" section, Dr. Smith's remark about the usage of the term "steep learning curve": "First, semantics. A steep learning curve is one where you gain proficiency over a short number of trials. That means the curve is steep. I think semantically we are really talking about a prolonged or long learning curve. I know it is a subtle distinction, but I can't miss the opportunity to make that point."
6. ^ *a* *b* *c* *d* *e* http://www.visualthesaurus.com/cm/wordroutes/a-steep-learning-curve-for-downton-abbey/ Ben Zimmer, February 8, 2013
7. ^ *Classics in the history of psychology*
8. ^ https://books.google.com/books?id=oRSMDF6y3l8C&printsec=frontcover#v=onepage&q&f=false page 42, Fig 2
9. ^ Bills, A.G. (1934). General experimental psychology. Longmans Psychology Series. (pp. 192-215). New York, NY: Longmans, Green and Co.
10. ^ https://www.bcgperspectives.com/content/Classics/strategy_the_experie BCJ 1968
11. ^ *Grant, Robert M. (2004), Contemporary strategy analysis, U.S., UK, Australia, Germany: Blackwell publishing, ISBN 1-4051-1999-3*

12. ^ *Hax, Arnoldo C.; Majluf, Nicolas S. (October 1982), "Competitive cost dynamics: the experience curve", Interfaces, **12** (5): 50–61, doi:10.1287/inte.12.5.50.*
13. ^ http://repository.cmu.edu/cgi/viewcontent.cgi?article=3420&context=compsci Mechanisms of skill acquisition and the law of practice Newell 1980
14. ^ Ritter, F. E., & Schooler, L. J. *The learning curve*. In *International Encyclopedia of the Social and Behavioral Sciences* (2002), 8602-8605. Amsterdam: Pergamon
15. ^ http://www.bgu.ac.il/~akarniel/pub/LeibowitzetalJMP2010.pdf
16. ^ *"Archived copy" (PDF). Archived from the original (PDF) on 2013-07-18. Retrieved 2013-03-17.* Department of Defense Manual Number 5000.2-M, mandates the use of learning curves for costing of defense programs (variable costs of production)
17. ^ *Sammut, Claude; Webb, Geoffrey I. (Eds.). Encyclopedia of Machine Learning (1st ed.). Springer. p. 578. ISBN 978-0-387-30768-8.*
18. ^ *Madhavan, P.G. (1997). "A New Recurrent Neural Network Learning Algorithm for Time Series Prediction" (PDF). Journal of Intelligent Systems. p. 113 Fig. 3.*
19. ^ *"Machine Learning 102: Practical Advice". Tutorial: Machine Learning for Astronomy with Scikit-learn.*
20. ^ *Meek, Christopher; Thiesson, Bo; Heckerman, David (Summer 2002). "The Learning-Curve Sampling Method Applied to Model-Based Clustering". Journal of Machine Learning Research. **2** (3): 397.*
21. ^ Connie JG Gersick 1991 "Revolutionary Change Theories: A Multilevel Exploration of the Punctuated Equilibrium Paradigm" The Academy of Management Review, Vol. 16, No. 1 pp. 10-36 1
22. ^ *"Towards the Limits of Precision and Accuracy in Measurement". Bibcode: 1988ptw..conf..291P.*
23. ^ ***a*** ***b*** *"Steep learning curves".*
24. ^ http://unix.rulez.org/~calver/pictures/curves.jpg Apparently from http://blogs.msdn.com/b/steverowe/archive/2004/11/17/code-editor-learning-curves.aspx Code Editor Learning Curves SteveRowe 17 Nov 2004 7:59 PM

25. ^ http://languagelog.ldc.upenn.edu/nll/?p=3767 "Downton Abbey" anachronisms: beyond nitpickery, Ben Zimmer, February 13, 2012
26. ^ http://languagelog.ldc.upenn.edu/nll/?p=3767 Comment by J Oliver : Season Three, episode 5

External links

- Learning curve

Categories: Learning | Cognitive science | Curves

This page was last edited on 26 May 2018, at 20:30.

Back to main TOC

Contents

Computational Linguistics

Jump to navigation Jump to search
This article is about the scientific field. For the journal, see Computational Linguistics (journal).

Computational linguistics is an interdisciplinary field concerned with the statistical or rule-based modeling of natural language from a computational perspective, as well as the study of appropriate computational approaches to linguistic questions.

Traditionally, computational linguistics was performed by computer scientists who had specialized in the application of computers to the processing of a natural language. Today, computational linguists often work as members of interdisciplinary teams, which can include regular linguists, experts in the target language, and computer scientists. In general, computational linguistics draws upon the involvement of linguists, computer scientists, experts in artificial intelligence, mathematicians, logicians, philosophers, cognitive scientists, cognitive psychologists, psycholinguists, anthropologists and neuroscientists, among others.

Computational linguistics has theoretical and applied components. Theoretical computational linguistics focuses on issues in theoretical linguistics and cognitive science, and applied computational linguistics focuses on the practical outcome of modeling human language use.[1]

The Association for Computational Linguistics defines computational linguistics as:

> ...the scientific study of language from a computational perspective. Computational linguists are interested in providing computational models of various kinds of linguistic phenomena.[2]

TOP

Origins

Computational linguistics is often grouped within the field of artificial intelligence, but actually was present before the development of artificial intelligence. Computational linguistics originated with efforts in the United States in the 1950s to use computers to automatically translate texts from foreign languages, particularly Russian scientific journals, into English.[3] Since computers can make arithmetic calculations much faster and more accurately than humans, it was thought to be only a short matter of time before they could also begin to process language.[4] Computational and quantitative methods are also used historically in attempted reconstruction of earlier forms of modern languages and subgrouping modern languages into language families. Earlier methods such as lexicostatistics and glottochronology have been proven to be premature and inaccurate. However, recent interdisciplinary studies which borrow concepts from biological studies, especially gene mapping, have proved to produce more sophisticated analytical tools and more trustful results.[5]

When machine translation (also known as mechanical translation) failed to yield accurate translations right away, automated processing of human languages was recognized as far more complex than had originally been assumed. Computational linguistics was born as the name of the new field of study devoted to developing algorithms and software for intelligently processing language data. The term "computational linguistics" itself was first coined by David Hays, founding member of both the Association for Computational Linguistics and the International Committee on Computational Linguistics.[6] When artificial intelligence came into existence in the 1960s, the field of computational linguistics became that sub-division of artificial intelligence dealing with human-level comprehension and production of natural languages.[*citation needed*]

In order to translate one language into another, it was observed that one had to understand the grammar of both languages, including both morphology (the grammar of word forms) and syntax (the grammar of sentence structure). In order to understand syntax, one had to also

understand the semantics and the lexicon (or 'vocabulary'), and even something of the pragmatics of language use. Thus, what started as an effort to translate between languages evolved into an entire discipline devoted to understanding how to represent and process natural languages using computers.[7]

Nowadays research within the scope of computational linguistics is done at computational linguistics departments,[8] computational linguistics laboratories,[9] computer science departments,[10] and linguistics departments.[11][12] Some research in the field of computational linguistics aims to create working speech or text processing systems while others aim to create a system allowing human-machine interaction. Programs meant for human-machine communication are called conversational agents.[13]

Approaches

Just as computational linguistics can be performed by experts in a variety of fields and through a wide assortment of departments, so too can the research fields broach a diverse range of topics. The following sections discuss some of the literature available across the entire field broken into four main area of discourse: developmental linguistics, structural linguistics, linguistic production, and linguistic comprehension.

Developmental approaches

Language is a cognitive skill which develops throughout the life of an individual. This developmental process has been examined using a number of techniques, and a computational approach is one of them. Human language development does provide some constraints which make it harder to apply a computational method to understanding it. For instance, during language acquisition, human children are largely only exposed to positive evidence.[14] This means that during the linguistic development of an individual, only evidence for what is a correct form is provided, and not evidence for what is not correct. This is insufficient information for a simple hypothesis testing procedure for information as complex as language,[15] and so provides certain boundaries for a computational approach to modeling language development and acquisition in an individual.

Attempts have been made to model the developmental process of language acquisition in children from a computational angle, leading to both statistical grammars and connectionist models.[16] Work in this realm has also been proposed as a method to explain the evolution of language through history. Using models, it has been shown that languages can be learned with a combination of simple input presented incrementally as the child develops better memory and longer attention span.[17] This was simultaneously posed as a reason for the long developmental period of human children.[17] Both conclusions were drawn because of the strength

of the artificial neural network which the project created.

The ability of infants to develop language has also been modeled using robots[18] in order to test linguistic theories. Enabled to learn as children might, a model was created based on an affordance model in which mappings between actions, perceptions, and effects were created and linked to spoken words. Crucially, these robots were able to acquire functioning word-to-meaning mappings without needing grammatical structure, vastly simplifying the learning process and shedding light on information which furthers the current understanding of linguistic development. It is important to note that this information could only have been empirically tested using a computational approach.

As our understanding of the linguistic development of an individual within a lifetime is continually improved using neural networks and learning robotic systems, it is also important to keep in mind that languages themselves change and develop through time. Computational approaches to understanding this phenomenon have unearthed very interesting information. Using the Price Equation and Pólya urn dynamics, researchers have created a system which not only predicts future linguistic evolution, but also gives insight into the evolutionary history of modern-day languages.[19] This modeling effort achieved, through computational linguistics, what would otherwise have been impossible.

It is clear that the understanding of linguistic development in humans as well as throughout evolutionary time has been fantastically improved because of advances in computational linguistics. The ability to model and modify systems at will affords science an ethical method of testing hypotheses that would otherwise be intractable.

TOC Previous Next

Structural approaches

In order to create better computational models of language, an understanding of language's structure is crucial. To this end, the English language has been meticulously studied using computational approaches to better understand how the language works on a structural level. One of

the most important pieces of being able to study linguistic structure is the availability of large linguistic corpora, or samples. This grants computational linguists the raw data necessary to run their models and gain a better understanding of the underlying structures present in the vast amount of data which is contained in any single language. One of the most cited English linguistic corpora is the Penn Treebank.[20] Derived from widely-different sources, such as IBM computer manuals and transcribed telephone conversations, this corpus contains over 4.5 million words of American English. This corpus has been primarily annotated using part-of-speech tagging and syntactic bracketing and has yielded substantial empirical observations related to language structure.[21]

Theoretical approaches to the structure of languages have also been developed. These works allow computational linguistics to have a framework within which to work out hypotheses that will further the understanding of the language in a myriad of ways. One of the original theoretical theses on internalization of grammar and structure of language proposed two types of models.[15] In these models, rules or patterns learned increase in strength with the frequency of their encounter.[15] The work also created a question for computational linguists to answer: how does an infant learn a specific and non-normal grammar (Chomsky Normal Form) without learning an overgeneralized version and getting stuck?[15] Theoretical efforts like these set the direction for research to go early in the lifetime of a field of study, and are crucial to the growth of the field.

Structural information about languages allows for the discovery and implementation of similarity recognition between pairs of text utterances.[22] For instance, it has recently been proven that based on the structural information present in patterns of human discourse, conceptual recurrence plots can be used to model and visualize trends in data and create reliable measures of similarity between natural textual utterances.[22] This technique is a strong tool for further probing the structure of human discourse. Without the computational approach to this question, the vastly complex information present in discourse data would have remained inaccessible to scientists.

Information regarding the structural data of a language is available for English as well as other languages, such as Japanese.[23] Using computational methods, Japanese sentence corpora were analyzed and a pattern of log-normality was found in relation to sentence length.[23] Though the exact cause of this lognormality remains unknown, it is precisely this sort of intriguing information which computational linguistics is designed to uncover. This information could lead to further important discoveries regarding the underlying structure of Japanese, and could have any number of effects on the understanding of Japanese as a language. Computational linguistics allows for very exciting additions to the scientific knowledge base to happen quickly and with very little room for doubt.

Without a computational approach to the structure of linguistic data, much of the information that is available now would still be hidden under the vastness of data within any single language. Computational linguistics allows scientists to parse huge amounts of data reliably and efficiently, creating the possibility for discoveries unlike any seen in most other approaches.

The production of language is equally as complex in the information it provides and the necessary skills which a fluent producer must have. That is to say, comprehension is only half the problem of communication. The other half is how a system produces language, and computational linguistics has made some very interesting discoveries in this area.

In a now famous paper published in 1950 Alan Turing proposed the possibility that machines might one day have the ability to "think". As a thought experiment for what might define the concept of thought in machines, he proposed an "imitation test" in which a human subject has two text-only conversations, one with a fellow human and another with a machine attempting to respond like a human. Turing proposes that if the subject cannot tell the difference between the human and the machine, it may be concluded that the machine is capable of thought.[24] Today this test is known as the Turing test and it remains an influential idea in the area of artificial intelligence.

One of the earliest and best known examples of a computer program designed to converse naturally with humans is the ELIZA program developed by Joseph Weizenbaum at MIT in 1966. The program emulated a Rogerian psychotherapist when responding to written statements and questions posed by a user. It appeared capable of understanding what was said to it and responding intelligently, but in truth it simply followed a pattern matching routine that relied on only understanding a few keywords in each sentence. Its responses were generated by recombining the unknown parts of the sentence around properly translated versions of the known words. For example, in the phrase "It seems that you hate me" ELIZA understands "you" and "me" which matches the general pattern "you [some words] me", allowing ELIZA to update the words "you" and "me" to "I" and "you" and replying "What makes you think I hate you?". In this example ELIZA has no understanding of the word "hate", but it is not required for a logical response in the context of this type of psychotherapy.[25]

Some projects are still trying to solve the problem which first started computational linguistics off as its own field in the first place. However, the methods have become more refined and clever, and consequently the results generated by computational linguists have become more enlightening. In an effort to improve computer translation, several models have been compared, including hidden Markov models, smoothing techniques, and the specific refinements of those to apply them to verb translation.[26] The model which was found to produce the most natural translations of German and French words was a refined alignment model with a first-order dependence and a fertility model[16]. They also provide efficient training algorithms for the models presented, which can give other scientists the ability to improve further on their results. This type of work is specific to computational linguistics, and has applications which could vastly improve understanding of how language is produced and comprehended by computers.

Work has also been done in making computers produce language in a more naturalistic manner. Using linguistic input from humans, algorithms have been constructed which are able to modify a system's style of production based on a factor such as linguistic input from a human, or more abstract

factors like politeness or any of the five main dimensions of personality.[27] This work takes a computational approach via parameter estimation models to categorize the vast array of linguistic styles we see across individuals and simplify it for a computer to work in the same way, making human-computer interaction much more natural.

TOC

Text-based interactive approach

Many of the earliest and simplest models of human-computer interaction, such as ELIZA for example, involve a text-based input from the user to generate a response from the computer. By this method, words typed by a user trigger the computer to recognize specific patterns and reply accordingly, through a process known as keyword spotting.

TOC

Speech-based interactive approach

Recent technologies have placed more of an emphasis on speech-based interactive systems. These systems, such as Siri of the iOS operating system, operate on a similar pattern-recognizing technique as that of text-based systems, but with the former, the user input is conducted through speech recognition. This branch of linguistics involves the processing of the user's speech as sound waves and the interpreting of the acoustics and language patterns in order for the computer to recognize the input.[28]

TOC Previous Next

Comprehension approaches

Much of the focus of modern computational linguistics is on comprehension. With the proliferation of the internet and the abundance of easily accessible written human language, the ability to create a program capable of understanding human language would have many broad and exciting possibilities, including improved search engines, automated customer service, and online education.

Early work in comprehension included applying Bayesian statistics to the task of optical character recognition, as illustrated by Bledsoe and Browing in 1959 in which a large dictionary of possible letters were generated by "learning" from example letters and then the probability that any one of those learned examples matched the new input was combined to make a final decision.[29] Other attempts at applying Bayesian statistics to language analysis included the work of Mosteller and Wallace (1963) in which an analysis of the words used in *The Federalist Papers* was used to attempt to determine their authorship (concluding that Madison most likely authored the majority of the papers).[30]

In 1971 Terry Winograd developed an early natural language processing engine capable of interpreting naturally written commands within a simple rule governed environment. The primary language parsing program in this project was called SHRDLU, which was capable of carrying out a somewhat natural conversation with the user giving it commands, but only within the scope of the toy environment designed for the task. This environment consisted of different shaped and colored blocks, and SHRDLU was capable of interpreting commands such as "Find a block which is taller than the one you are holding and put it into the box." and asking questions such as "I don't understand which pyramid you mean." in response to the user's input.[31] While impressive, this kind of natural language processing has proven much more difficult outside the limited scope of the toy environment. Similarly a project developed by NASA called LUNAR was designed to provide answers to naturally written questions about the geological analysis of lunar rocks returned by the Apollo missions.[32] These kinds of problems are referred to as question answering.

Initial attempts at understanding spoken language were based on work done in the 1960s and 1970s in signal modeling where an unknown signal is analyzed to look for patterns and to make predictions based on its history. An initial and somewhat successful approach to applying this kind of signal modeling to language was achieved with the use of hidden Markov models as detailed by Rabiner in 1989.[33] This approach attempts to determine probabilities for the arbitrary number of models that could be

being used in generating speech as well as modeling the probabilities for various words generated from each of these possible models. Similar approaches were employed in early speech recognition attempts starting in the late 70s at IBM using word/part-of-speech pair probabilities.[34]

More recently these kinds of statistical approaches have been applied to more difficult tasks such as topic identification using Bayesian parameter estimation to infer topic probabilities in text documents.[35]

Applications

Modern computational linguistics is often a combination of studies in computer science and programming, math, particularly statistics, language structures, and natural language processing. Combined, these fields most often lead to the development of systems that can recognize speech and perform some task based on that speech. Examples include speech recognition software, such as Apple's Siri feature, spellcheck tools, speech synthesis programs, which are often used to demonstrate pronunciation or help the disabled, and machine translation programs and websites, such as Google Translate and Word Reference.[36]

Computational linguistics can be especially helpful in situations involving social media and the Internet. For example, filters in chatrooms or on website searches require computational linguistics. Chat operators often use filters to identify certain words or phrases and deem them inappropriate so that users cannot submit them.[36] Another example of using filters is on websites. Schools use filters so that websites with certain keywords are blocked from children to view. There are also many programs in which parents use Parental controls to put content filters in place. Computational linguists can also develop programs that group and organize content through Social media mining. An example of this is Twitter, in which programs can group tweets by subject or keywords.[37] Computational linguistics is also used for document retrieval and clustering. When you do an online search, documents and websites are retrieved based on the frequency of unique labels related to what you typed into a search engine. For instance, if you search "red, large, four-wheeled vehicle," with the intention of finding pictures of a red truck, the search engine will still find the information desired by matching words such as "four-wheeled" with "car".[38]

Subfields

Computational linguistics can be divided into major areas depending upon the medium of the language being processed, whether spoken or textual; and upon the task being performed, whether analyzing language (recognition) or synthesizing language (generation).

Speech recognition and speech synthesis deal with how spoken language can be understood or created using computers. Parsing and generation are sub-divisions of computational linguistics dealing respectively with taking language apart and putting it together. Machine translation remains the sub-division of computational linguistics dealing with having computers translate between languages. The possibility of automatic language translation, however, has yet to be realized and remains a notoriously hard branch of computational linguistics.[39]

Some of the areas of research that are studied by computational linguistics include:

- Computational complexity of natural language, largely modeled on automata theory, with the application of context-sensitive grammar and linearly bounded Turing machines.
- Computational semantics comprises defining suitable logics for linguistic meaning representation, automatically constructing them and reasoning with them
- Computer-aided corpus linguistics, which has been used since the 1970s as a way to make detailed advances in the field of discourse analysis[40]
- Design of parsers or chunkers for natural languages
- Design of taggers like POS-taggers (part-of-speech taggers)
- Machine translation as one of the earliest and most difficult applications of computational linguistics draws on many subfields.
- Simulation and study of language evolution in historical linguistics/ glottochronology.

Legacy

The subject of computational linguistics has had a recurring impact on popular culture:

- The 1983 film *WarGames* features a young computer hacker who interacts with an artificially intelligent supercomputer.[41]
- A 1997 film, *Conceiving Ada*, focuses on Ada Lovelace, considered one of the first computer scientists, as well as themes of computational linguistics.[42]
- *Her*, a 2013 film, depicts a man's interactions with the "world's first artificially intelligent operating system."[43]
- The 2014 film *The Imitation Game* follows the life of computer scientist Alan Turing, developer of the Turing Test.[44]
- The 2015 film *Ex Machina* centers around human interaction with artificial intelligence.[45]

TOC Previous Next

See also

References

1. ^ Hans Uszkoreit. What Is Computational Linguistics? [1] Department of Computational Linguistics and Phonetics of Saarland University
2. ^ The Association for Computational Linguistics What is Computational Linguistics? Published online, Feb, 2005.
3. ^ John Hutchins: Retrospect and prospect in computer-based translation. Proceedings of MT Summit VII, 1999, pp. 30–44.
4. ^ Arnold B. Barach: Translating Machine 1975: And the Changes To Come.
5. ^ T. Crowley., C. Bowern. An Introduction to Historical Linguistics. Auckland, N.Z.: Oxford UP, 1992. Print.
6. ^ *"Deceased members". ICCL members. Retrieved 15 November 2017.*
7. ^ Natural Language Processing by Liz Liddy, Eduard Hovy, Jimmy Lin, John Prager, Dragomir Radev, Lucy Vanderwende, Ralph Weischedel
8. ^ "Computational Linguistics and Phonetics".
9. ^ "Yatsko's Computational Linguistics Laboratory".
10. ^ "CLIP".
11. ^ Computational Linguistics – Department of Linguistics – Georgetown College
12. ^ "UPenn Linguistics: Computational Linguistics".
13. ^ Jurafsky, D., & Martin, J. H. (2009). Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition. Upper Saddle River, N.J: Pearson Prentice Hall.
14. ^ Bowerman, M. (1988). The "no negative evidence" problem: How do children avoid constructing an overly general grammar. Explaining language universals.
15. ^ ***a b c d*** Braine, M.D.S. (1971). On two types of models of the internalization of grammars. In D.I. Slobin (Ed.), The ontogenesis of grammar: A theoretical perspective. New York: Academic Press.
16. ^ Powers, D.M.W. & Turk, C.C.R. (1989). *Machine Learning of*

Natural Language. Springer-Verlag. ISBN 978-0-387-19557-5.
17. ^ ***a*** ***b*** Elman, J. (1993). Learning and development in neural networks: The importance of starting small. Cognition, 71-99.
18. ^ Salvi, G., Montesano, L., Bernardino, A., & Santos-Victor, J. (2012). Language bootstrapping: learning word meanings from perception-action association. IEEE transactions on systems, man, and cybernetics. Part B, Cybernetics : a publication of the IEEE Systems, Man, and Cybernetics Society, 42(3), 660-71. doi: 10.1109/TSMCB.2011.2172420
19. ^ *Gong, T.; Shuai, L.; Tamariz, M. & Jäger, G. (2012). E. Scalas, ed. "Studying Language Change Using Price Equation and Pólya-urn Dynamics". PLoS ONE.* ***7*** *(3): e33171. doi:10.1371/journal.pone.0033171.*
20. ^ *Marcus, M. & Marcinkiewicz, M. (1993). "Building a large annotated corpus of English: The Penn Treebank" (PDF). Computational linguistics.* ***19*** *(2): 313–330.*
21. ^ *Taylor, Ann (2003). "1". Treebanks. Spring Netherlands. pp. 5–22.*
22. ^ ***a*** ***b*** *Angus, D.; Smith, A. & Wiles, J. (2012). "Conceptual recurrence plots: revealing patterns in human discourse". IEEE transactions on visualization and computer graphics.* ***18*** *(6): 988–97. doi:10.1109/TVCG.2011.100.*
23. ^ ***a*** ***b*** *Furuhashi, S. & Hayakawa, Y. (2012). "Lognormality of the Distribution of Japanese Sentence Lengths". Journal of the Physical Society of Japan.* ***81*** *(3): 034004. doi:10.1143/JPSJ.81.034004.*
24. ^ *Turing, A. M. (1950). "Computing machinery and intelligence". Mind.* ***59*** *(236): 433–460. doi:10.1093/mind/lix.236.433. JSTOR 10.2307/2251299.*
25. ^ *Weizenbaum, J. (1966). "ELIZA—a computer program for the study of natural language communication between man and machine". Communications of the ACM.* ***9*** *(1): 36–45. doi:10.1145/365153.365168.*
26. ^ *Och, F. J.; Ney, H. (2003). "A Systematic Comparison of Various Statistical Alignment Models". Computational Linguistics.* ***29*** *(1): 19–51. doi:10.1162/089120103321337421.*
27. ^ *Mairesse, F. (2011). "Controlling user perceptions of linguistic style: Trainable generation of personality traits". Computational*

Linguistics. **37** (3): 455–488. doi:10.1162/COLI_a_00063.

28. ^ *Language Files*. The Ohio State University Department of Linguistics. 2011. pp. 624–634. ISBN 9780814251799.
29. ^ Bledsoe, W. W. & Browning, I. (1959). Pattern recognition and reading by machine. Papers presented at the December 1–3, 1959, eastern joint IRE-AIEE-ACM computer conference on - IRE-AIEE-ACM '59 (Eastern). New York, New York, USA: ACM Press. pp. 225–232. doi:10.1145/1460299.1460326.
30. ^ Mosteller, F. (1963). "Inference in an authorship problem". *Journal of the American Statistical Association*. **58** (302): 275–309. doi:10.2307/2283270. JSTOR 10.2307/2283270.
31. ^ Winograd, T. (1971). "Procedures as a Representation for Data in a Computer Program for Understanding Natural Language" (Report).
32. ^ Woods, W.; Kaplan, R. & Nash-Webber, B. (1972). "The lunar sciences natural language information system" (Report).
33. ^ Rabiner, L. (1989). "A tutorial on hidden Markov models and selected applications in speech recognition". *Proceedings of the IEEE*. doi:10.1109/5.18626.
34. ^ Bahl, L.; Baker, J.; Cohen, P.; Jelinek, F. (1978). "Recognition of continuously read natural corpus". *Acoustics, Speech, and Signal*. **3**: 422–424. doi:10.1109/ICASSP.1978.1170402.
35. ^ Blei, D. & Ng, A. (2003). "Latent dirichlet allocation". *The Journal of Machine Learning*. **3**: 993–1022.
36. ^ ***a*** ***b*** "Careers in Computational Linguistics". California State University. Retrieved 19 September 2016.
37. ^ Marujo, Lus et al. "Automatic Keyword Extraction on Twitter." Language Technologies Institute, Carnegie Mellon University, n.d. Web. 19 Sept. 2016.
38. ^ "Computational Linguistics". Stanford Encyclopedia of Philosophy. Feb 26, 2014. Retrieved Apr 19, 2017.
39. ^ Oettinger, A. G. (1965). Computational Linguistics. The American Mathematical Monthly, Vol. 72, No. 2, Part 2: Computers and Computing, pp. 147-150.
40. ^ McEnery, Thomas (1996). *Corpus Linguistics: An Introduction*. Edinburgh: Edinburgh University Press. p. 114. ISBN 0748611657.

41. ^ *Badham, John (1983-06-03), WarGames, retrieved 2016-02-22*
42. ^ *Hershman-Leeson, Lynn (1999-02-19), Conceiving Ada, retrieved 2016-02-22*
43. ^ *Jonze, Spike (2014-01-10), Her, retrieved 2016-02-18*
44. ^ *Tyldum, Morten (2014-12-25), The Imitation Game, retrieved 2016-02-18*
45. ^ *Garland, Alex (2015-04-24), Ex Machina, retrieved 2016-02-18*

Further reading

- Bates, M (1995). "Models of natural language understanding". *Proceedings of the National Academy of Sciences of the United States of America*. **92** (22): 9977–9982. doi: 10.1073/pnas.92.22.9977. PMC 40721 .
- Steven Bird, Ewan Klein, and Edward Loper (2009). *Natural Language Processing with Python*. O'Reilly Media. ISBN 978-0-596-51649-9.
- Daniel Jurafsky and James H. Martin (2008). *Speech and Language Processing*, 2nd edition. Pearson Prentice Hall. ISBN 978-0-13-187321-6.
- Mohamed Zakaria KURDI (2016). *Natural Language Processing and Computational Linguistics: speech, morphology, and syntax*, Volume 1. ISTE-Wiley. ISBN 978-1848218482.
- Mohamed Zakaria KURDI (2017). *Natural Language Processing and Computational Linguistics: semantics, discourse, and applications*, Volume 2. ISTE-Wiley. ISBN 978-1848219212.

External links

- Association for Computational Linguistics (ACL)
  - ACL Anthology of research papers
  - ACL Wiki for Computational Linguistics
- CICLing annual conferences on Computational Linguistics
- Computational Linguistics – Applications workshop
- Free online introductory book on Computational Linguistics at the Wayback Machine (archived January 25, 2008)
- Language Technology World
- Resources for Text, Speech and Language Processing
- The Research Group in Computational Linguistics

Categories: Computational linguistics | Applied linguistics | Formal sciences | Cognitive science | Computational fields of study

This page was last edited on 29 May 2018, at 21:11.

Back to main TOC

Contents

Functionalism (philosophy of mind)

Jump to navigation Jump to search

Functionalism is a view in the theory of the mind. It states that mental states (beliefs, desires, being in pain, etc.) are constituted solely by their functional role – that is, they have causal relations to other mental states, numerous sensory inputs, and behavioral outputs.[1] Functionalism developed largely as an alternative to the identity theory of mind and behaviorism.

Functionalism is a theoretical level between the physical implementation and behavioral output.[2] Therefore, it is different from its predecessors of Cartesian dualism (advocating independent mental and physical substances) and Skinnerian behaviorism and physicalism (declaring only physical substances) because it is only concerned with the effective functions of the brain, through its organization or its "software programs".

Since mental states are identified by a functional role, they are said to be realized on multiple levels; in other words, they are able to be manifested in various systems, even perhaps computers, so long as the system performs the appropriate functions. While computers are physical devices with electronic substrate that perform computations on inputs to give outputs, so brains are physical devices with neural substrate that perform computations on inputs which produce behaviors.

TOP

TOC Next

Multiple realizability

An important part of some accounts of functionalism is the idea of multiple realizability. Since, according to standard functionalist theories, mental states are the corresponding functional role, mental states can be sufficiently explained without taking into account the underlying physical medium (e.g. the brain, neurons, etc.) that realizes such states; one need only take into account the higher-level functions in the cognitive system. Since mental states are not limited to a particular medium, they can be realized in multiple ways, including, theoretically, within non-biological systems, such as computers. In other words, a silicon-based machine could, in principle, have the same sort of mental life that a human being has, provided that its cognitive system realized the proper functional roles. Thus, mental states are individuated much like a valve; a valve can be made of plastic or metal or whatever material, as long as it performs the proper function (say, controlling the flow of liquid through a tube by blocking and unblocking its pathway).

However, there have been some functionalist theories that combine with the identity theory of mind, which deny multiple realizability. Such *Functional Specification Theories* (FSTs) (Levin, § 3.4), as they are called, were most notably developed by David Lewis [3] and David Malet Armstrong .[4] According to FSTs, mental states are the particular "realizers" of the functional role, not the functional role itself. The mental state of belief, for example, just is whatever brain or neurological process that realizes the appropriate belief function. Thus, unlike standard versions of functionalism (often called *Functional State Identity Theories*), FSTs do not allow for the multiple realizability of mental states, because the fact that mental states are realized by brain states is essential. What often drives this view is the belief that if we were to encounter an alien race with a cognitive system composed of significantly different material from humans' (e.g., silicon-based) but performed the same functions as human mental states (e.g., they tend to yell "Yowzas!" when poked with sharp objects, etc.) then we would say that their type of mental state is perhaps similar to ours, but too different to say it's the same. For some, this may be a disadvantage to FSTs. Indeed, one of Hilary Putnam's[5][6] arguments

for his version of functionalism relied on the intuition that such alien creatures would have the same mental states as humans do, and that the multiple realizability of standard functionalism makes it a better theory of mind.

TOC Previous Next

Types

Machine-state functionalism

The broad position of "functionalism" can be articulated in many different varieties. The first formulation of a functionalist theory of mind was put forth by Hilary Putnam[5][6] in the 1960s. This formulation, which is now called **machine-state functionalism**, or just **machine functionalism**, was inspired by the analogies which Putnam and others noted between the mind and the theoretical "machines" or computers capable of computing any given algorithm which were developed by Alan Turing (called **Turing machines**). It should be noted that Putnam himself, by the mid-1970s, had begun questioning this position. The beginning of his opposition to machine-state functionalism can be read about in his Twin Earth Thought Experiment.

In non-technical terms, a Turing machine is not a physical object, but rather an abstract machine built upon a mathematical model. Typically, a Turing Machine has a horizontal tape divided into rectangular cells arranged from left to right. The tape itself is infinite in length, and each cell may contain a symbol. The symbols used for any given "machine" can vary. The machine has a *read-write head* that scans cells and moves in left and right directions. The action of the machine is determined by the symbol in the cell being scanned and a table of transition rules that serve as the machine's programming. Because of the infinite tape, a traditional Turing Machine has an infinite amount of time to compute any particular function or any number of functions. In the below example, each cell is either blank (*B*) or has a *1* written on it. These are the inputs to the machine. The possible outputs are:

- Halt: Do nothing.
- *R*: move one square to the right.
- *L*: move one square to the left.
- *B*: erase whatever is on the square.

- *1*: erase whatever is on the square and print a '1.

An extremely simple example of a Turing machine which writes out the sequence '111' after scanning three blank squares and then stops as specified by the following machine table:

This table states that if the machine is in state one and scans a blank square (*B*), it will print a *1* and remain in state one. If it is in state one and reads a *1*, it will move one square to the right and also go into state two. If it is in state two and reads a *B*, it will print a *1* and stay in state two. If it is in state two and reads a *1*, it will move one square to the right and go into state three. If it is in state three and reads a *B*, it prints a *1* and remains in state three. Finally, if it is in state three and reads a *1*, then it will stay in state three.

The essential point to consider here is the *nature of the states* of the Turing machine. Each state can be defined exclusively in terms of its relations to the other states as well as inputs and outputs. State one, for example, is simply the state in which the machine, if it reads a *B*, writes a *1* and stays in that state, and in which, if it reads a *1*, it moves one square to the right and goes into a different state. This is the functional definition of state one; it is its causal role in the overall system. The details of how it accomplishes what it accomplishes and of its material constitution are completely irrelevant.

The above point is critical to an understanding of machine-state functionalism. Since Turing machines are not required to be physical systems, "anything capable of going through a succession of states in time can be a Turing machine".[7] Because biological organisms “go through a succession of states in time”, any such organisms could also be equivalent to Turing machines.

According to machine-state functionalism, the nature of a mental state is just like the nature of the Turing machine states described above. If one can show the rational functioning and computing skills of these machines to be comparable to the rational functioning and computing skills of human beings, it follows that Turing machine behavior closely resembles that of human beings.[8] Therefore, it is not a particular physical-chemical

composition responsible for the particular machine or mental state, it is the programming rules which produce the effects that are responsible. To put it another way, any rational preference is due to the rules being followed, not to the specific material composition of the agent.

TOC Previous Next

Psycho functionalism

A second form of functionalism is based on the rejection of behaviorist theories in psychology and their replacement with empirical cognitive models of the mind. This view is most closely associated with Jerry Fodor and Zenon Pylyshyn and has been labeled **psychofunctionalism**.

The fundamental idea of psychofunctionalism is that psychology is an irreducibly complex science and that the terms that we use to describe the entities and properties of the mind in our best psychological theories cannot be redefined in terms of simple behavioral dispositions, and further, that such a redefinition would not be desirable or salient were it achievable. Psychofunctionalists view psychology as employing the same sorts of irreducibly teleological or purposive explanations as the biological sciences. Thus, for example, the function or role of the heart is to pump blood, that of the kidney is to filter it and to maintain certain chemical balances and so on—this is what accounts for the purposes of scientific explanation and taxonomy. There may be an infinite variety of physical realizations for all of the mechanisms, but what is important is only their role in the overall biological theory. In an analogous manner, the role of mental states, such as belief and desire, is determined by the functional or causal role that is designated for them within our best *scientific* psychological theory. If some mental state which is postulated by folk psychology (e.g. hysteria) is determined not to have any fundamental role in cognitive psychological explanation, then that particular state may be considered not to exist . On the other hand, if it turns out that there are states which theoretical cognitive psychology posits as necessary for explanation of human behavior but which are not foreseen by ordinary folk psychological language, then these entities or states exist.

Analytic functionalism

A third form of functionalism is concerned with the meanings of theoretical terms in general. This view is most closely associated with David Lewis and is often referred to as **analytic functionalism** or **conceptual functionalism**. The basic idea of analytic functionalism is that theoretical terms are implicitly defined by the theories in whose formulation they occur and not by intrinsic properties of the phonemes they comprise. In the case of ordinary language terms, such as "belief", "desire", or "hunger", the idea is that such terms get their meanings from our common-sense "folk psychological" theories about them, but that such conceptualizations are not sufficient to withstand the rigor imposed by materialistic theories of reality and causality. Such terms are subject to conceptual analyses which take something like the following form:

> Mental state M is the state that is preconceived by P and causes Q.

For example, the state of **pain** is *caused* by sitting on a tack and *causes* loud cries, and higher order mental states of anger and resentment directed at the careless person who left a tack lying around. These sorts of functional definitions in terms of causal roles are claimed to be *analytic* and *a priori* truths about the submental states and the (largely fictitious) propositional attitudes they describe. Hence, its proponents are known as *analytic* or *conceptual* functionalists. The essential difference between analytic and psychofunctionalism is that the latter emphasizes the importance of laboratory observation and experimentation in the determination of which mental state terms and concepts are genuine and which functional identifications may be considered to be genuinely contingent and *a posteriori* identities. The former, on the other hand, claims that such identities are necessary and not subject to empirical scientific investigation.

Homuncular functionalism

Homuncular functionalism was developed largely by Daniel Dennett and has been advocated by William Lycan. It arose in response to the challenges that Ned Block's China Brain (a.k.a. Chinese nation) and John Searle's Chinese room thought experiments presented for the more traditional forms of functionalism (see below under "Criticism"). In attempting to overcome the conceptual difficulties that arose from the idea of a nation full of Chinese people wired together, each person working as a single neuron to produce in the wired-together whole the functional mental states of an individual mind, many functionalists simply bit the bullet, so to speak, and argued that such a Chinese nation would indeed possess all of the qualitative and intentional properties of a mind; i.e. it would become a sort of systemic or collective mind with propositional attitudes and other mental characteristics. Whatever the worth of this latter hypothesis, it was immediately objected that it entailed an unacceptable sort of mind-mind supervenience: the *systemic* mind which somehow emerged at the higher-level must necessarily supervene on the individual minds of each individual member of the Chinese nation, to stick to Block's formulation. But this would seem to put into serious doubt, if not directly contradict, the fundamental idea of the supervenience thesis: there can be no change in the mental realm without some change in the underlying physical substratum. This can be easily seen if we label the set of mental facts that occur at the higher-level *M1* and the set of mental facts that occur at the lower-level *M2*. Given the transitivity of supervenience, if *M1* supervenes on *M2*, and *M2* supervenes on *P* (physical base), then *M1* and *M2* both supervene on *P*, even though they are (allegedly) totally different sets of mental facts.

Since mind-mind supervenience seemed to have become acceptable in functionalist circles, it seemed to some that the only way to resolve the puzzle was to postulate the existence of an entire hierarchical series of mind levels (analogous to homunculi) which became less and less sophisticated in terms of functional organization and physical composition all the way down to the level of the physico-mechanical neuron or group of neurons. The homunculi at each level, on this view, have authentic mental properties but become simpler and less intelligent as one works one's way down the hierarchy.

Mechanistic functionalism

Mechanistic functionalism, originally formulated and defended by Gualtiero Piccinini [9] and Carl Gillett[10][11] independently, augments previous functionalist accounts of mental states by maintaining that any psychological explanation must be rendered in mechanistic terms. That is, instead of mental states receiving a purely functional explanation in terms of their relations to other mental states, like those listed above, functions are seen as playing only a part—the other part being played by structures — of the explanation of a given mental state.

A mechanistic explanation[12] involves decomposing a given system, in this case a mental system, into its component physical parts, their activities or functions, and their combined organizational relations.[9] On this account the mind remains a functional system, but one that is understood mechanistically. This account remains a sort of functionalism because functional relations are still essential to mental states, but it is mechanistic because the functional relations are always manifestations of concrete structures—albeit structures understood at a certain level of abstraction. Functions are individuated and explained either in terms of the contributions they make to the given system[13] or in teleological terms. If the functions are understood in teleological terms, then they may be characterized either etiologically or non-etiologically.[14]

Mechanistic functionalism leads functionalism away from the traditional functionalist autonomy of psychology from neuroscience and towards integrating psychology and neuroscience.[15] By providing an applicable framework for merging traditional psychological models with neurological data, mechanistic functionalism may be understood as reconciling the functionalist theory of mind with neurological accounts of how the brain actually works. This is due to the fact that mechanistic explanations of function attempt to provide an account of how functional states (mental states) are physically realized through neurological mechanisms.

Physicalism

There is much confusion about the sort of relationship that is claimed to exist (or not exist) between the general thesis of functionalism and physicalism. It has often been claimed that functionalism somehow "disproves" or falsifies physicalism *tout court* (i.e. without further explanation or description). On the other hand, most philosophers of mind who are functionalists claim to be physicalists—indeed, some of them, such as David Lewis, have claimed to be strict reductionist-type physicalists.

Functionalism is fundamentally what Ned Block has called a broadly metaphysical thesis as opposed to a narrowly ontological one. That is, functionalism is not so much concerned with *what there is* than with what it is that characterizes a certain type of mental state, e.g. pain, as the type of state that it is. Previous attempts to answer the mind-body problem have all tried to resolve it by answering *both* questions: dualism says there are two substances and that mental states are characterized by their immateriality; behaviorism claimed that there was one substance and that mental states were behavioral disposition; physicalism asserted the existence of just one substance and characterized the mental states as physical states (as in "pain = C-fiber firings").

On this understanding, **type physicalism** can be seen as incompatible with functionalism, since it claims that what characterizes mental states (e.g. pain) is that they are physical in nature, while functionalism says that what characterizes pain is its functional/causal role and its relationship with yelling "ouch", etc. However, any weaker sort of physicalism which makes the simple ontological claim that everything that exists is made up of physical matter is perfectly compatible with functionalism. Moreover, most functionalists who are physicalists require that the properties that are quantified over in functional definitions be physical properties. Hence, they *are* physicalists, even though the general thesis of functionalism itself does not commit them to being so.

In the case of David Lewis, there is a distinction in the concepts of "having

pain" (a rigid designator true of the same things in all possible worlds) and just "pain" (a non-rigid designator). Pain, for Lewis, stands for something like the definite description "the state with the causal role x". The referent of the description in humans is a type of brain state to be determined by science. The referent among silicon-based life forms is something else. The referent of the description among angels is some immaterial, non-physical state. For Lewis, therefore, *local* type-physical reductions are possible and compatible with conceptual functionalism. (See also Lewis's mad pain and Martian pain.) There seems to be some confusion between types and tokens that needs to be cleared up in the functionalist analysis.

Criticism

China brain

Main article: China brain

Ned Block[16] argues against the functionalist proposal of multiple realizability, where hardware implementation is irrelevant because only the functional level is important. The "China brain" or "Chinese nation" thought experiment involves supposing that the entire nation of China systematically organizes itself to operate just like a brain, with each individual acting as a neuron. (The tremendous difference in speed of operation of each unit is not addressed.). According to functionalism, so long as the people are performing the proper functional roles, with the proper causal relations between inputs and outputs, the system will be a real mind, with mental states, consciousness, and so on. However, Block argues, this is patently absurd, so there must be something wrong with the thesis of functionalism since it would allow this to be a legitimate description of a mind.

Some functionalists believe China would have qualia but that due to the size it is impossible to imagine China being conscious.[17] Indeed, it may be the case that we are constrained by our theory of mind[18] and will never be able to understand what Chinese-nation consciousness is like. Therefore, if functionalism is true either qualia will exist across all hardware or will not exist at all but are illusory.[19]

The Chinese room

Main article: Chinese room

The Chinese room argument by John Searle [20] is a direct attack on the claim that thought can be represented as a set of functions. The thought

experiment asserts that it is possible to mimic intelligent action without any interpretation or understanding through the use of a purely functional system. In short, Searle describes a person who only speaks English who is in a room with only Chinese symbols in baskets and a rule book in English for moving the symbols around. The person is then ordered by people outside of the room to follow the rule book for sending certain symbols out of the room when given certain symbols. Further suppose that the people outside of the room are Chinese speakers and are communicating with the person inside via the Chinese symbols. According to Searle, it would be absurd to claim that the English speaker inside knows Chinese simply based on these syntactic processes. This thought experiment attempts to show that systems which operate merely on syntactic processes (inputs and outputs, based on algorithms) cannot realize any semantics (meaning) or intentionality (aboutness). Thus, Searle attacks the idea that thought can be equated with following a set of syntactic rules; that is, functionalism is an insufficient theory of the mind.

As noted above, in connection with Block's Chinese nation, many functionalists responded to Searle's thought experiment by suggesting that there was a form of mental activity going on at a higher level than the man in the Chinese room could comprehend (the so-called "system reply"); that is, the system does know Chinese. Of course, Searle responds that there is nothing more than syntax going on at the higher-level as well, so this reply is subject to the same initial problems. Furthermore, Searle suggests the man in the room could simply memorize the rules and symbol relations. Again, though he would convincingly mimic communication, he would be aware only of the symbols and rules, not of the meaning behind them.

Inverted spectrum

Main article: Inverted spectrum

Another main criticism of functionalism is the inverted spectrum or inverted qualia scenario, most specifically proposed as an objection to functionalism by Ned Block.[16][21] This thought experiment involves

supposing that there is a person, call her Jane, that is born with a condition which makes her see the opposite spectrum of light that is normally perceived. Unlike normal people, Jane sees the color violet as yellow, orange as blue, and so forth. So, suppose, for example, that you and Jane are looking at the same orange. While you perceive the fruit as colored orange, Jane sees it as colored blue. However, when asked what color the piece of fruit is, both you and Jane will report "orange". In fact, one can see that all of your behavioral as well as functional relations to colors will be the same. Jane will, for example, properly obey traffic signs just as any other person would, even though this involves the color perception. Therefore, the argument goes, since there can be two people who are functionally identical, yet have different mental states (differing in their qualitative or phenomenological aspects), functionalism is not robust enough to explain individual differences in qualia.[22]

David Chalmers tries to show[23] that even though mental content cannot be fully accounted for in functional terms, there is nevertheless a *nomological correlation* between mental states and functional states in this world. A silicon-based robot, for example, whose functional profile matched our own, would *have* to be fully conscious. His argument for this claim takes the form of a *reductio ad absurdum*. The general idea is that since it would be very unlikely for a conscious human being to experience a change in its qualia which it utterly fails to notice, mental content and functional profile appear to be inextricably bound together, at least in the human case. If the subject's qualia were to change, we would expect the subject to notice, and therefore his functional profile to follow suit. A similar argument is applied to the notion of *absent* qualia. In this case, Chalmers argues that it would be very unlikely for a subject to experience a fading of his qualia which he fails to notice and respond to. This, coupled with the independent assertion that a conscious being's functional profile just could be maintained, irrespective of its experiential state, leads to the conclusion that the subject of these experiments would remain fully conscious. The problem with this argument, however, as Brian G. Crabb (2005) has observed, is that it begs the central question: How could Chalmers *know* that functional profile can be preserved, for example while the conscious subject's brain is being supplanted with a silicon substitute, unless he already assumes that the subject's possibly changing qualia

would not be a determining factor? And while changing or fading qualia in a conscious subject might force changes in its functional profile, this tells us nothing about the case of a permanently inverted or unconscious robot. A subject with inverted qualia from birth would have nothing to notice or adjust to. Similarly, an unconscious functional simulacrum of ourselves (a zombie) would have no experiential changes to notice or adjust to. Consequently, Crabb argues, Chalmers' "fading qualia" and "dancing qualia" arguments fail to establish that cases of permanently inverted or absent qualia are nomologically impossible.

A related critique of the inverted spectrum argument is that it assumes that mental states (differing in their qualitative or phenomenological aspects) can be independent of the functional relations in the brain. Thus, it begs the question of functional mental states: its assumption denies the possibility of functionalism itself, without offering any independent justification for doing so. (Functionalism says that mental states are produced by the functional relations in the brain.) This same type of problem—that there is no argument, just an antithetical assumption at their base—can also be said of both the Chinese room and the Chinese nation arguments. Notice, however, that Crabb's response to Chalmers does not commit this fallacy: His point is the more restricted observation that *even if* inverted or absent qualia turn out to be nomologically impossible, and it is perfectly possible that we might subsequently discover this fact by other means, Chalmers' argument fails to demonstrate that they are impossible.

Twin Earth

Main article: Twin Earth thought experiment

The Twin Earth thought experiment, introduced by Hilary Putnam,[24] is responsible for one of the main arguments used against functionalism, although it was originally intended as an argument against semantic internalism. The thought experiment is simple and runs as follows. Imagine a Twin Earth which is identical to Earth in every way but one: water does not have the chemical structure H_2O, but rather some other structure, say XYZ. It is critical, however, to note that XYZ on Twin Earth

is still called "water" and exhibits all the same macro-level properties that H_2O exhibits on Earth (i.e., XYZ is also a clear drinkable liquid that is in lakes, rivers, and so on). Since these worlds are identical in every way except in the underlying chemical structure of water, you and your Twin Earth doppelgänger see exactly the same things, meet exactly the same people, have exactly the same jobs, behave exactly the same way, and so on. In other words, since you share the same inputs, outputs, and relations between other mental states, you are functional duplicates. So, for example, you both believe that water is wet. However, the content of your mental state of believing that water is wet differs from your duplicate's because your belief is of H_2O, while your duplicate's is of XYZ. Therefore, so the argument goes, since two people can be functionally identical, yet have different mental states, functionalism cannot sufficiently account for all mental states.

Most defenders of functionalism initially responded to this argument by attempting to maintain a sharp distinction between internal and external content. The internal contents of propositional attitudes, for example, would consist exclusively in those aspects of them which have no relation with the external world *and* which bear the necessary functional/causal properties that allow for relations with other internal mental states. Since no one has yet been able to formulate a clear basis or justification for the existence of such a distinction in mental contents, however, this idea has generally been abandoned in favor of externalist *causal theories of mental contents* (also known as informational semantics). Such a position is represented, for example, by Jerry Fodor's account of an "asymmetric causal theory" of mental content. This view simply entails the modification of functionalism to include within its scope a very broad interpretation of input and outputs to include the objects that are the causes of mental representations in the external world.

The twin earth argument hinges on the assumption that experience with an imitation water would cause a different mental state than experience with natural water. However, since no one would notice the difference between the two waters, this assumption is likely false. Further, this basic assumption is directly antithetical to functionalism; and, thereby, the twin earth argument does not constitute a genuine argument: as this assumption

entails a flat denial of functionalism itself (which would say that the two waters would not produce different mental states, because the functional relationships would remain unchanged).

Meaning holism

Another common criticism of functionalism is that it implies a radical form of semantic holism. Block and Fodor[21] referred to this as the *damn/darn problem*. The difference between saying "damn" or "darn" when one smashes one's finger with a hammer can be mentally significant. But since these outputs are, according to functionalism, related to many (if not all) internal mental states, two people who experience the same pain and react with different outputs must share little (perhaps nothing) in common in any of their mental states. But this is counter-intuitive; it seems clear that two people share something significant in their mental states of being in pain if they both smash their finger with a hammer, whether or not they utter the same word when they cry out in pain.

Another possible solution to this problem is to adopt a moderate (or molecularist) form of holism. But even if this succeeds in the case of pain, in the case of beliefs and meaning, it faces the difficulty of formulating a distinction between relevant and non-relevant contents (which can be difficult to do without invoking an analytic-synthetic distinction, as many seek to avoid).

Triviality arguments

According to Ned Block, if functionalism is to avoid the chauvinism of type-physicalism, it becomes overly liberal in "ascribing mental properties to things that do not in fact have them".[16] As an example, he proposes that the economy of Bolivia might be organized such that the economic states, inputs, and outputs would be isomorphic to a person under some bizarre mapping from mental to economic variables.[16]

Hilary Putnam,[25] John Searle,[26] and others[27][28] have offered further arguments that functionalism is trivial, i.e. that the internal structures functionalism tries to discuss turn out to be present everywhere, so that either functionalism turns out to reduce to behaviorism, or to complete triviality and therefore a form of panpsychism. These arguments typically use the assumption that physics leads to a progression of unique states, and that functionalist realization is present whenever there is a mapping from the proposed set of mental states to physical states of the system. Given that the states of a physical system are always at least slightly unique, such a mapping will always exist, so any system is a mind. Formulations of functionalism which stipulate absolute requirements on interaction with external objects (external to the functional account, meaning not defined functionally) are reduced to behaviorism instead of absolute triviality, because the input-output behavior is still required.

Peter Godfrey-Smith has argued further[29] that such formulations can still be reduced to triviality if they accept a somewhat innocent-seeming additional assumption. The assumption is that adding a *transducer layer*, that is, an input-output system, to an object should not change whether that object has mental states. The transducer layer is restricted to producing behavior according to a simple mapping, such as a lookup table, from inputs to actions on the system, and from the state of the system to outputs. However, since the system will be in unique states at each moment and at each possible input, such a mapping will always exist so there will be a transducer layer which will produce whatever physical behavior is desired.

Godfrey-Smith believes that these problems can be addressed using causality, but that it may be necessary to posit a continuum between objects being minds and not being minds rather than an absolute distinction. Furthermore, constraining the mappings seems to require either consideration of the external behavior as in behaviorism, or discussion of the internal structure of the realization as in identity theory; and though multiple realizability does not seem to be lost, the functionalist claim of the autonomy of high-level functional description becomes questionable.[29]

TOC | ← Previous | Next →

Anapoiesis

The general theory of adaptive biological systems, named practopoiesis (meaning *creation of actions*), has been used to derive a theory that explains mental operations as an adaptive process. Much like species adapt through evolution and an organism adapts through development, the theory of anapoiesis (meaning *re-creation*) proposes that a thought is a process of adaptation to the immediate environment. This is performed by fast physiological machinery that can operate within a few 100s of milliseconds and relies on the mechanisms of neural adaptation. A key difference between anapoietic approach and the functional approach is that for anapoietic process much of the information needed for the mental operations is located outside the organism. If mental operations are an adaptive process, they do not juggle symbols internally (like a computer) but make guesses of what changes should be made to the nervous system and then test them against the environment.

The mechanisms of anapoiesis offer a solution to the problem of the Chinese Room posed by John Searle.

See also

- Cognitive science
- Consciousness
- Explanatory gap
- Functional psychology
- Hard problem of consciousness
- Personhood in Western philosophy
- Philosophical zombie
- Philosophy of mind
- Reverse engineering
- Simulated consciousness
- Turing test

References

1. ^ Block, Ned. (1996). "What is functionalism?" a revised version of the entry on functionalism in *The Encyclopedia of Philosophy Supplement*, Macmillan. (PDF online)
2. ^ Marr, D. (1982). *Vision: A Computational Approach*. San Francisco: Freeman & Co.
3. ^ Lewis, David. (1980). "Mad Pain and Martian Pain". In Block (1980a) Vol. 1, pp. 216–222.
4. ^ Armstrong, D.M. (1968). *A Materialistic Theory of the Mind*. London: RKP.
5. ^ ***a b*** Putnam, Hilary. (1960). "Minds and Machines". Reprinted in Putnam (1975a).
6. ^ ***a b*** Putnam, Hilary. (1967). "Psychological Predicates". In *Art, Mind, and Religion*, W.H. Capitan and D.D. Merrill (eds.), pp. 37–48. (Later published as "The Nature of Mental States" in Putnam (1975a).
7. ^ Putnam, H. (1967). “The Mental Life of Some Machines,” in H.-N. Castaneda (Ed.), Intentionality, Minds, and Perception. Detroit, MI: Wayne State University Press, p. 183.
8. ^ Putnam, H. (1967). “The Mental Life of Some Machines,” in H.-N. Castaneda (Ed.), Intentionality, Minds, and Perception. Detroit, MI: Wayne State University Press, pp. 179-180.
9. ^ ***a b*** Piccinini G (2010). "The mind as neural software? Understanding functionalism, computationalism, and computational functionalism". *Philosophy and Phenomenological Research*. **81** (2): 269–311. doi:10.1111/j.1933-1592.2010.00356.x.
10. ^ Gillett, C. (2007). “A Mechanist Manifesto for the Philosophy of Mind: The Third Way for Functionalists”. Journal of Philosophical Research, invited symposium on “Mechanisms in the Philosophy of Mind”, vol.32, pp. 21-42.
11. ^ Gillett, C. (2013). “Understanding the Sciences through the Fog of ‘Functionalism(s)’”. In Hunneman (ed.) Functions: Selection and Mechanisms. Dordrecht: Kluwer, pp.159-81.
12. ^ Machamer P.; Darden L.; Craver C. F. (2000). "Thinking about mechanisms". *Philosophy of Science*. **67** (1): 1–25. doi:10.1086/392759.
13. ^ Craver C. F. (2001). "Role functions, mechanisms, and hierarchy". *Philosophy of Science*. **68** (1): 53–74. doi:10.1086/392866.
14. ^ Maley C. J.; Piccinini G. (2013). "Get the Latest Upgrade: Functionalism 6.3.1". *Philosophia Scientiae*. **17** (2): 135–149.
15. ^ Piccinini G.; Craver C. F. (2011). "Integrating psychology and neuroscience: Functional analyses as mechanism sketches". *Synthese*. **183** (3): 283–311. doi:10.1007/s11229-011-9898-4.
16. ^ ***a b c d*** Block, Ned. (1980b). "Troubles With Functionalism", in (1980a).
17. ^ Lycan, William (1987). *Consciousness*. Cambridge, Massachusetts: MIT Press.

ISBN 9780262121248.

18. ^ Baron-Cohen, Simon; Leslie, Alan M.; Frith, Uta (October 1985). "Does the autistic child have a "theory of mind"?". *Cognition*. Elsevier. **21** (1): 37–46. doi:10.1016/0010-0277(85)90022-8. PMID 2934210. Pdf.
19. ^ Dennett, Daniel (1990), "Quining Qualia", in Lycan, William G., *Mind and cognition: a reader*, Cambridge, Massachusetts, USA: Basil Blackwell, ISBN 9780631160762.
20. ^ Searle, John (1980). "Minds, Brains and Programs". *Behavioral and Brain Sciences*. **3**. doi:10.1017/s0140525x00005756. Archived from the original on 2001-02-21.
21. ^ *a b* Block, Ned and Fodor, J. (1972). "What Psychological States Are Not". *Philosophical Review* 81.
22. ^ Block, Ned. (1994). Qualia. In S. Guttenplan (ed), *A Companion to Philosophy of Mind*. Oxford: Blackwell
23. ^ Chalmers, David. (1996). *The Conscious Mind*. Oxford: Oxford University Press.
24. ^ Putnam, Hilary. (1975b). "The Meaning of 'Meaning' ", reprinted in Putnam (1975a).(PDF online Archived June 18, 2013, at the Wayback Machine.)
25. ^ Putnam, H. (1988). *Reality and representation*. Appendix. Cambridge, MA: MIT Press.
26. ^ Searle J (1990). "Is the brain a digital computer?". *Proceedings and Addresses of the American Philosophical Association*. **64**: 21–37. doi:10.2307/3130074.
27. ^ Chalmers D (1996). "Does a rock implement every finite-state automaton?". *Synthese*. **108**: 309–333. doi:10.1007/bf00413692.
28. ^ Copeland J (1996). "What is computation?". *Synthese*. **108**: 335–359. doi:10.1007/bf00413693.
29. ^ *a b* Peter Godfrey-Smith, "Triviality Arguments against Functionalism". 2009. Philosophical studies 145 (2). [1]/"Archived copy" (PDF). Archived from the original (PDF) on 2011-05-22. Retrieved 2011-02-06.

Further reading

- Armstrong, D.M. (1968). *A Materialistic Theory of the Mind*. London: RKP.
- Baron-Cohen S.; Leslie A.; Frith U. (1985). "Does the Autistic Child Have a "Theory of Mind"?". *Cognition*. **21**: 37–46. doi: 10.1016/0010-0277(85)90022-8. PMID 2934210.
- Block, Ned. (1980a). "Introduction: What Is Functionalism?" in *Readings in Philosophy of Psychology*. Cambridge, MA: Harvard University Press.
- Block, Ned. (1980b). "Troubles With Functionalism", in Block (1980a).
- Block, Ned. (1994). Qualia. In S. Guttenplan (ed), *A Companion to Philosophy of Mind*. Oxford: Blackwell
- Block, Ned (1996). "What is functionalism?" (PDF). a revised version of the entry on functionalism in *The Encyclopedia of Philosophy Supplement*, Macmillan.
- Block, Ned and Fodor, J. (1972). "What Psychological States Are Not". *Philosophical Review* 81.
- Chalmers, David. (1996). *The Conscious Mind*. Oxford: Oxford University Press.
- Crabb, B.G. (2005). "Fading and Dancing Qualia - Moving and Shaking Arguments", Deunant Books.
- DeLancey, C. (2002). "Passionate Engines - What Emotions Reveal about the Mind and Artificial Intelligence." Oxford: Oxford University Press.
- Dennett, D. (1990) Quining Qualia. In W. Lycan, (ed), *Mind and Cognition*. Oxford: Blackwells
- Levin, Janet. (2004). "Functionalism", *The Stanford Encyclopedia of Philosophy* (Fall 2004 Edition), E. Zalta (ed.). (online)
- Lewis, David. (1966). "An Argument for the Identity Theory". *Journal of Philosophy* 63.
- Lewis, David. (1980). "Mad Pain and Martian Pain". In Block (1980a) Vol. 1, pp. 216–222.
- Lycan, W. (1987) *Consciousness*. Cambridge, MA: MIT Press.
- Mandik, Pete. (1998). *Fine-grained Supervience, Cognitive Neuroscience, and the Future of Functionalism*.
- Marr, D. (1982). *Vision: A Computational Approach*. San Francisco: Freeman & Co.
- Polgar, T. D. (2008). "Functionalism". *The Internet Encyclopedia of Philosophy*.
- Putnam, Hilary. (1960). "Minds and Machines". Reprinted in Putnam (1975a).
- Putnam, Hilary. (1967). "Psychological Predicates". In *Art, Mind, and Religion*, W.H. Capitan and D.D. Merrill (eds.), pp. 37–48. (Later published as "The Nature of Mental States" in Putnam (1975a).
- Putnam, Hilary. (1975a). *Mind, Language, and Reality*. Cambridge: CUP.
- Searle, John (1980). "Minds, Brains and Programs". *Behavioral and Brain Sciences*. **3**. doi:

10.1017/s0140525x00005756. Archived from the original on 2001-02-21.

- Smart, J.J.C. (1959). "Sensations and Brain Processes". *Philosophical Review* LXVIII.

TOC Previous

External links

- Stanford Encyclopedia of Philosophy
- Dictionary of the Philosophy of Mind

Categories: Cognition | Cognitive science | Mind–body problem | Theory of mind | Contemporary philosophy

This page was last edited on 30 April 2018, at 20:22.

Back to main TOC

Contents

Generative adversarial Network

Jump to navigation Jump to search
Not to be confused with Adversarial machine learning.

Generative adversarial networks (**GANs**) are a class of artificial intelligence algorithms used in unsupervised machine learning, implemented by a system of two neural networks contesting with each other in a zero-sum game framework. They were introduced by Ian Goodfellow *et al.* in 2014.[1] This technique can generate photographs that look at least superficially authentic to human observers, having many realistic characteristics (though in tests people can tell real from generated in many cases).[2]

TOP

TOC Next

Method

One network generates candidates and the other evaluates them.[3][4][5][6] Typically, the generative network learns to map from a latent space to a particular data distribution of interest, while the discriminative network discriminates between instances from the true data distribution and candidates produced by the generator. The generative network's training objective is to increase the error rate of the discriminative network (i.e., "fool" the discriminator network by producing novel synthesised instances that appear to have come from the true data distribution).[3][7]

In practice, a known dataset serves as the initial training data for the discriminator. Training the discriminator involves presenting it with samples from the dataset, until it reaches some level of accuracy. Typically the generator is seeded with a randomized input that is sampled from a predefined latent space[4] (e.g. a multivariate normal distribution). Thereafter, samples synthesized by the generator are evaluated by the discriminator. Backpropagation is applied in both networks [5] so that the generator produces better images, while the discriminator becomes more skilled at flagging synthetic images.[8] The generator is typically a deconvolutional neural network, and the discriminator is a convolutional neural network.

The idea to infer models in a competitive setting (model versus discriminator) was proposed by Li, Gauci and Gross in 2013.[9] Their method is used for behavioral inference. It is termed Turing Learning,[10] as the setting is akin to that of a Turing test. Turing Learning is a generalization of GANs.[11] Models other than neural networks can be considered. Moreover, the discriminators are allowed to influence the processes from which the datasets are obtained, making them active interrogators as in the Turing test. The idea of adversarial training can also be found in earlier works, such as Schmidhuber in 1992.[12]

Application

GANs have been used to produce samples of photorealistic images for the purposes of visualizing new interior/industrial design, shoes, bags and clothing items or items for computer game's' scenes.[citation needed] These networks were reported to be used by Facebook.[13] Recently, GANs have modeled patterns of motion in video.[14] They have also been used to reconstruct 3D models of objects from images[15] and to improve astronomical images.[16] In 2017 a fully convolutional feedforward GAN was used for image enhancement using automated texture synthesis in combination with perceptual loss. The system focused on realistic textures rather than pixel-accuracy. The result was a higher image quality at high magnification.[17]

References

1. ^ *Goodfellow, Ian; Pouget-Abadie, Jean; Mirza, Mehdi; Xu, Bing; Warde-Farley, David; Ozair, Sherjil; Courville, Aaron; Bengio, Joshua (2014). "Generative Adversarial Networks". arXiv:1406.2661 [cs.LG].*
2. ^ *Salimans, Tim; Goodfellow, Ian; Zaremba, Wojciech; Cheung, Vicki; Radford, Alec; Chen, Xi (2016). "Improved Techniques for Training GANs". arXiv:1606.03498 [cs.LG].*
3. ^ ***a*** ***b*** *Goodfellow, Ian J.; Pouget-Abadie, Jean; Mirza, Mehdi; Xu, Bing; Warde-Farley, David; Ozair, Sherjil; Courville, Aaron; Bengio, Yoshua (2014). "Generative Adversarial Networks". arXiv:1406.2661 [stat.ML].*
4. ^ ***a*** ***b*** Thaler, SL, US Patent 05659666, Device for the autonomous generation of useful information, 08/19/1997.
5. ^ ***a*** ***b*** Thaler, SL, US Patent, 07454388, Device for the autonomous bootstrapping of useful information, 11/18/2008.
6. ^ Thaler, SL, The Creativity Machine Paradigm, Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship, (ed.) E.G. Carayannis, Springer Science+Business Media, LLC, 2013.
7. ^ *Luc, Pauline; Couprie, Camille; Chintala, Soumith; Verbeek, Jakob (2016-11-25). "Semantic Segmentation using Adversarial Networks". NIPS Workshop on Adversarial Training, Dec , Barcelona, Spain.* ***2016****. arXiv:1611.08408 .*
8. ^ *Andrej Karpathy, Pieter Abbeel, Greg Brockman, Peter Chen, Vicki Cheung, Rocky Duan, Ian Goodfellow, Durk Kingma, Jonathan Ho, Rein Houthooft, Tim Salimans, John Schulman, Ilya Sutskever, And Wojciech Zaremba, Generative Models, OpenAI, retrieved April 7, 2016*
9. ^ *Li, Wei; Gauci, Melvin; Gross, Roderich (July 6, 2013). "A Coevolutionary Approach to Learn Animal Behavior Through Controlled Interaction". Proceedings of the 15th Annual Conference on Genetic and Evolutionary Computation (GECCO 2013). Amsterdam, The Netherlands: ACM. pp. 223–230.*
10. ^ *Li, Wei; Gauci, Melvin; Groß, Roderich (30 August 2016). "Turing*

learning: a metric-free approach to inferring behavior and its application to swarms". *Swarm Intelligence*. **10** (3): 211–243. doi:10.1007/s11721-016-0126-1.
11. ^ Gross, Roderich; Gu, Yue; Li, Wei; Gauci, Melvin (December 6, 2017). "Generalizing GANs: A Turing Perspective". *Proceedings of the Thirty-first Annual Conference on Neural Information Processing Systems (NIPS 2017)*. Long Beach, CA, USA. pp. 1–11.
12. ^ Schmidhuber, Jürgen (November 1992). "Learning Factorial Codes by Predictability Minimization". *Neural Computation*. **4** (6): 863–879. doi:10.1162/neco.1992.4.6.863.
13. ^ Greenemeier, Larry (June 20, 2016). "When Will Computers Have Common Sense? Ask Facebook". *Scientific American*. Retrieved July 31, 2016.
14. ^ "Generating Videos with Scene Dynamics". *web.mit.edu*.
15. ^ "3D Generative Adversarial Network". *3dgan.csail.mit.edu*.
16. ^ Schawinski, Kevin; Zhang, Ce; Zhang, Hantian; Fowler, Lucas; Santhanam, Gokula Krishnan (2017-02-01). "Generative Adversarial Networks recover features in astrophysical images of galaxies beyond the deconvolution limit". *Monthly Notices of the Royal Astronomical Society: Letters*. **467**: L110–L114. arXiv:1702.00403 . Bibcode: 2017MNRAS.467L.110S. doi:10.1093/mnrasl/slx008.
17. ^ Sajjadi, Mehdi S. M.; Schölkopf, Bernhard; Hirsch, Michael (2016-12-23). "EnhanceNet: Single Image Super-Resolution Through Automated Texture Synthesis". arXiv:1612.07919 [cs.CV].

TOC Previous

External links

- *Knight, Will. "What to expect of artificial intelligence in 2017". MIT Technology Review. Retrieved 2017-01-05.*

Categories:

- Neural networks
- Cognitive science
- Unsupervised learning

This page was last edited on 17 May 2018, at 22:40.

Back to main TOC

Contents

Informatics

Jump to navigation Jump to search
This article is about the discipline. For other uses, see Informatics (disambiguation).

Informatics is a branch of information engineering. It involves the practice of information processing and the engineering of information systems, and as an academic field it is an applied form of information science. The field considers the interaction between humans and information alongside the construction of interfaces, organisations, technologies and systems. As such, the field of informatics has great breadth and encompasses many subspecialties, including disciplines of computer science, information systems, information technology and statistics. Since the advent of computers, individuals and organizations increasingly process information digitally. This has led to the study of informatics with computational, mathematical, biological, cognitive and social aspects, including study of the social impact of information technologies.

TOP

TOC Next

Etymology

See also: Computer science § Etymology

In 1956 the German computer scientist Karl Steinbuch coined the word *Informatik* by publishing a paper called *Informatik: Automatische Informationsverarbeitung* ("Informatics: Automatic Information Processing").[1] The English term *Informatics* is sometimes understood as meaning the same as computer science. The German word *Informatik* is usually translated to English as *computer science*.

The French term *informatique* was coined in 1962 by Philippe Dreyfus[2] together with various translations—informatics (English), also proposed independently and simultaneously by Walter F. Bauer and associates who co-founded *Informatics Inc.*, and *informatica* (Italian, Spanish, Romanian, Portuguese, Dutch), referring to the application of computers to store and process information.

The term was coined as a combination of "information" and "automatic" to describe the science of automating information interactions. The morphology—*informat*-ion + -*ics*—uses "the accepted form for names of sciences, as conics, linguistics, optics, or matters of practice, as economics, politics, tactics",[3] and so, linguistically, the meaning extends easily to encompass both the science of information and the practice of information processing.

History

See also: History of computer science and History of computing

The culture of library science promotes policies and procedures for managing information that fosters the relationship between library science and the development of information science to provide benefits for health informatics development; which is traced to the 1950s with the beginning of computer uses in healthcare (Nelson & Staggers p.4). Early practitioners interested in the field soon learned that there were no formal education programs set up to educate them on the informatics science until the late 1960s and early 1970s. Professional development began to emerge, playing a significant role in the development of health informatics (Nelson &Staggers p.7) According to Imhoff et al., 2001, healthcare informatics is not only the application of computer technology to problems in healthcare but covers all aspects of generation, handling, communication, storage, retrieval, management, analysis, discovery, and synthesis of data information and knowledge in the entire scope of healthcare. Furthermore, they stated that the primary goal of health informatics can be distinguished as follows: To provide solutions for problems related to data, information, and knowledge processing. To study general principles of processing data information and knowledge in medicine and healthcare.

Reference Imhoff, M., Webb. A,.&Goldschmidt, A., (2001). Health Informatics. Intensive Care Med, 27: 179-186. doi:10.1007//s001340000747.

Nelson, R. & Staggers, N. Health Informatics: An Interprofessional Approach. St. Louis: Mosby, 2013. Print. (p.4,7)

This new term was adopted across Western Europe, and, except in English, developed a meaning roughly translated by the English ‘computer science’, or ‘computing science’. Mikhailov advocated the Russian term *informatika* (1966), and the English *informatics* (1967), as names for the

theory of scientific information, and argued for a broader meaning, including study of the use of information technology in various communities (for example, scientific) and of the interaction of technology and human organizational structures.

> *Informatics is the discipline of science which investigates the structure and properties (not specific content) of scientific information, as well as the regularities of scientific information activity, its theory, history, methodology and organization.*[4]

Usage has since modified this definition in three ways. First, the restriction to scientific information is removed, as in business informatics or legal informatics. Second, since most information is now digitally stored, computation is now central to informatics. Third, the representation, processing and communication of information are added as objects of investigation, since they have been recognized as fundamental to any scientific account of information. Taking *information* as the central focus of study distinguishes *informatics* from *computer science*. Informatics includes the study of biological and social mechanisms of information processing whereas computer science focuses on the digital computation. Similarly, in the study of representation and communication, informatics is indifferent to the substrate that carries information. For example, it encompasses the study of communication using gesture, speech and language, as well as digital communications and networking.

In the English-speaking world the term *informatics* was first widely used in the compound medical informatics, taken to include "the cognitive, information processing, and communication tasks of medical practice, education, and research, including information science and the technology to support these tasks".[5] Many such compounds are now in use; they can be viewed as different areas of "*applied informatics*". Indeed, "In the U.S., however, informatics is linked with applied computing, or computing in the context of another domain."[6]

Informatics encompasses the study of systems that represent, process, and communicate information. However, the theory of computation in the specific discipline of theoretical computer science, which evolved

from Alan Turing, studies the notion of a complex system regardless of whether or not information actually exists. Since both fields process information, there is some disagreement among scientists as to field hierarchy; for example Arizona State University attempted to adopt a broader definition of informatics to even encompass cognitive science at the launch of its School of Computing and Informatics in September 2006.

A broad interpretation of *informatics*, as "the study of the structure, algorithms, behaviour, and interactions of natural and artificial computational systems," was introduced by the University of Edinburgh in 1994 when it formed the grouping that is now its School of Informatics. This meaning is now (2006) increasingly used in the United Kingdom.[7]

The 2008 Research Assessment Exercise, of the UK Funding Councils, includes a new, *Computer Science and Informatics*, unit of assessment (UoA),[8] whose scope is described as follows:

> *The UoA includes the study of methods for acquiring, storing, processing, communicating and reasoning about information, and the role of interactivity in natural and artificial systems, through the implementation, organisation and use of computer hardware, software and other resources. The subjects are characterised by the rigorous application of analysis, experimentation and design.*

Academic schools and departments

Academic research in the informatics area can be found in a number of disciplines such as computer science, information technology, Information and Computer Science, information system, business information management and health informatics.

In France, the first degree level qualifications in Informatics (computer science) appeared in the mid-1960s.[*citation needed*]

In English-speaking countries, the first example of a degree level qualification in Informatics occurred in 1982 when Plymouth Polytechnic (now the University of Plymouth) offered a four-year BSc(Honours) degree in Computing and Informatics – with an initial intake of only 35 students. The course still runs today [9] making it the longest available qualification in the subject.

At the Indiana University School of Informatics, Computing, and Engineering (Bloomington, Indianapolis and Southeast), informatics is defined as "the art, science and human dimensions of information technology" and "the study, application, and social consequences of technology." It is also defined in Informatics 101, Introduction to Informatics as "the application of information technology to the arts, sciences, and professions." These definitions are widely accepted in the United States, and differ from British usage in omitting the study of natural computation.

Texas Woman's University places its informatics degrees in its department of Mathematics and Computer Science within the College of Arts & Sciences, though it offers interdisciplinary Health Informatics degrees.[10] Informatics is presented in a generalist framework, as evidenced by their definition of informatics ("Using technology and data analytics to derive meaningful information from data for data and decision driven practice in user centered systems"), though TWU is also known for its nursing and health informatics programs.

At the University of California, Irvine Department of Informatics, informatics is defined as "the interdisciplinary study of the design, application, use and impact of information technology. The discipline of informatics is based on the recognition that the design of this technology is not solely a technical matter, but must focus on the relationship between the technology and its use in real-world settings. That is, informatics designs solutions in context, and takes into account the social, cultural and organizational settings in which computing and information technology will be used."

At the University of Michigan, Ann Arbor Informatics interdisciplinary major, informatics is defined as "the study of information and the ways information is used by and affects human beings and social systems. The major involves coursework from the College of Literature, Science and the Arts, where the Informatics major is housed, as well as the School of Information and the College of Engineering. Key to this growing field is that it applies both technological and social perspectives to the study of information. Michigan's interdisciplinary approach to teaching Informatics gives a solid grounding in contemporary computer programming, mathematics, and statistics, combined with study of the ethical and social science aspects of complex information systems. Experts in the field help design new information technology tools for specific scientific, business, and cultural needs." Michigan offers four curricular tracks within the informatics degree to provide students with increased expertise. These four track topics include:[11]

- *Internet Informatics*: An applied track in which students experiment with technologies behind Internet-based information systems and acquire skills to map problems to deployable Internet-based solutions. This track will replace Computational Informatics in Fall 2013.[12]
- Data Mining & Information Analysis: Integrates the collection, analysis, and visualization of complex data and its critical role in research, business, and government to provide students with practical skills and a theoretical basis for approaching challenging data analysis problems.
- *Life Science Informatics*: Examines artificial information systems, which has helped scientists make great progress in identifying core

components of organisms and ecosystems.

- Social Computing: Advances in computing have created opportunities for studying patterns of social interaction and developing systems that act as introducers, recommenders, coordinators, and record-keepers. Students, in this track, craft, evaluate, and refine social software computer applications for engaging technology in unique social contexts. This track will be phased out in Fall 2013 in favor of the new bachelor of science in information. This will be the first undergraduate degree offered by the School of Information since its founding in 1996. The School of Information already contains a Master's program, Doctorate program, and a professional master's program in conjunction with the School of Public Health. The BS in Information at the University of Michigan will be the first curriculum program of its kind in the United States, with the first graduating class to emerge in 2015. Students will be able to apply for this unique degree in 2013 for the 2014 Fall semester; the new degree will be a stem off of the most popular Social Computing track in the current Informatics interdisciplinary major in LSA. Applications will be open to upper-classmen, juniors and seniors, along with a variety of information classes available for first and second year students to gauge interest and value in the specific sector of study. The degree was approved by the University on June 11, 2012.[13] Along with a new degree in the School of Information, there has also been the first and only chapter of an Informatics Professional Fraternity, Kappa Theta Pi, chartered in Fall 2012.[14]

At the University of Washington, Seattle Informatics Undergraduate Program, Informatics is an undergraduate program offered by the Information School. Bachelor of Science in Informatics is described as "[a] program that focuses on computer systems from a user-centered perspective and studies the structure, behavior and interactions of natural and artificial systems that store, process and communicate information. Includes instruction in information sciences, human computer interaction, information system analysis and design, telecommunications structure and information architecture and management." Washington offers three degree options as well as a custom track.[15]

- Data Science Option: Data Science is an emerging interdisciplinary field that works to extract knowledge or insight from data. It combines fields such as information science, computer science, statistics, design, and social science.
- Human-Computer Interaction: The iSchool's work in human-computer interaction (HCI) strives to make information and computing useful, usable, and accessible to all. The Informatics HCI option allows one to blend your technical skills and expertise with a broader perspective on how design and development work impacts users. Courses explore the design, construction, and evaluation of interactive technologies for use by individuals, groups, and organizations, and the social implications of these systems. This work encompasses user interfaces, accessibility concerns, new design techniques and methods for interactive systems and collaboration. Coursework also examines the values implicit in the design and development of technology.
- Information Architecture: Information architecture (IA) is a crucial component in the development of successful Web sites, software, intranets, and online communities. Architects structure the underlying information and its presentation in a logical and intuitive way so that people can put information to use. As an Informatics major with an IA option, one will master the skills needed to organize and label information for improved navigation and search. One will build frameworks to effectively collect, store and deliver information. One will also learn to design the databases and XML storehouses that drive complex and interactive websites, including the navigation, content layout, personalization, and transactional features of the site.
- Information Assurance and Cybersecurity: Information Assurance and Cybersecurity (IAC) is the practice of creating and managing safe and secure systems. It is crucial for organizations public and private, large and small. In the IAC option, one will be equipped with the knowledge to create, deploy, use, and manage systems that preserve individual and organizational privacy and security. This tri-campus concentration leverages the strengths of the Information School, the Computing and Software Systems program at UW Bothell, and the Institute of Technology at UW Tacoma. After a course in the technical, policy, and management foundations of IAC, one may take

electives at any campus to learn such specialties as information assurance policy, secure coding, or networking and systems administration.

- Custom (Student-Designed Concentration): Students may choose to develop their own concentration, with approval from the academic adviser. Student-designed concentrations are created out of a list of approved courses and also result in the Bachelor of Science degree.

TOC Previous Next

Applied disciplines

See also: Category:Information science by discipline.

TOC Previous Next

Organizational informatics

Main article: Organizational informatics

One of the most significant areas of application of informatics is that of organizational informatics. Organizational informatics is fundamentally interested in the application of information, information systems and ICT within organisations of various forms including private sector, public sector and voluntary sector organisations.[16][17] As such, organisational informatics can be seen to be a sub-category of social informatics and a super-category of business informatics. Organizational informatics are also present in the computer science and information technology industry.[18]

TOC Previous Next

See also

- Artificial intelligence
- Behavior informatics
- Biomimetics
- Cognitive science
- Computer science
- Communication studies
- Information and communications technology
- Information processing
- Information science
- Information systems
- Information theory
- Information technology
- Knowledge Management
- Robotics
- Urban informatics

TOC Previous Next

Notes

1. ^ Karl Steinbuch Eulogy – Bernard Widrow, Reiner Hartenstein, Robert Hecht-Nielsen
2. ^ Dreyfus, Phillipe. *L'informatique*. Gestion, Paris, June 1962, pp. 240–41
3. ^ Oxford English Dictionary 1989
4. ^ Mikhailov, A.I., Chernyl, A.I., and Gilyarevskii, R.S. (1966) "Informatika – novoe nazvanie teorii naučnoj informacii." *Naučno tehničeskaja informacija*, 12, pp. 35–39.
5. ^ Greenes, R.A. and Shortliffe, E.H. (1990) "Medical Informatics: An emerging discipline with academic and institutional perspectives." *Journal of the American Medical Association*, 263(8) pp. 1114–20.
6. ^ [1]
7. ^ For example, at University of Reading, Sussex, City University, Ulster Archived 2006-04-20 at the Wayback Machine., Bradford Archived 2006-05-17 at the Wayback Machine., Manchester and Newcastle Archived 2003-09-07 at Archive.is
8. ^ UoA 23 Computer Science and Informatics, Panel working methods
9. ^ BSc(Hons) Computing Informatics – University of Plymouth Link
10. ^ *"Informatics - Texas Woman's University"*.
11. ^ *"Curriculum - Informatics - University of Michigan". University of Michigan. Retrieved 6 February 2013.*
12. ^ *"Concentration: Informatics - LSA Students - University of Michigan". archive.li. 7 January 2013. Archived from the original on 7 January 2013.*
13. ^ *"UMSI plans new undergraduate degree". University of Michigan School of Information. Archived from the original on 21 December 2012. Retrieved 11 February 2013.*
14. ^ *"Kappa Theta Pi (KTP)". Archived from the original on 2 September 2013. Retrieved 19 February 2013.*

15. ^ *"Degree Options"*. *University of Washington Information School. Retrieved 6 April 2015.*
16. ^ Beynon-Davies P. (2002). Information Systems: an introduction to informatics in Organisations. Palgrave, Basingstoke, UK. ISBN 0-333-96390-3
17. ^ Beynon-Davies P. (2009). Business Information Systems. Palgrave, Basingstoke, UK. ISBN 978-0-230-20368-6
18. ^

External links

- informatics:[1] entry from International Encyclopedia of Information and Library Science
- Informatics Studies: Journal of Centre for Informatics Research and Development
- Software History Center: First usage of *informatics* in the US
- What is Informatics? : Indiana University
- Q&A about informatics
- Prior Art Database: Informatics: An Early Software Company
- Informatics Europe
- The Council of European Professional Informatics Societies (CEPIS)
- Informatics Department, College of Computing and Information, University at Albany - State University of New York
- Department of Informatics, King's College London
- *An Informatics Education: What and who is it for?*, from Northern Kentucky University
- Texas Woman's University's Informatics on Facebook
- Institution of Mechanical Engineers - Mechatronics, Informatics and Control Group (MICG)
- https://www.coursehero.com/file/23728173/Academic-schools-and-departments-on-literature-infomatics/
- Informatics: 10 Years Back, 10 years Ahead[2]

1. ^ *"Informatics" (PDF).*
2. ^ *Informatics : 10 years back, 10 years ahead. Wilhelm, R. (Reinhard), 1946-. Berlin: Springer. 2001. ISBN 9783540416357. OCLC 45873721.*

Categories:

- Artificial intelligence
- Cognitive science

- Computer science education
- Information science
- Schools of informatics

This page was last edited on 18 April 2018, at 14:09.

Back to main TOC

Contents

Behavioural Sciences

Jump to navigation Jump to search
For the movement within psychology from the 1910s to 1960s, see Behaviorism.
For the journal, see Systems Research and Behavioral Science.

The term **behavioral sciences** encompasses the various disciplines that explores the cognitive processes within organisms and the behavioural interactions between organisms in the natural world. It involves the systematic analysis and investigation of human and animal behavior through the study of the past, controlled and naturalistic observation of the present, and disciplined scientific experimentation. It attempts to accomplish legitimate, objective conclusions through rigorous formulations and observation.[1] Examples of behavioral sciences include psychology, psychobiology, anthropology, and cognitive science. Generally, behavior science deals primarily with human action and often seeks to generalize about human behavior as it relates to society.[2]

The term *behavioral sciences* is often confused with the term *social sciences*. Though these two broad areas are interrelated and study systematic processes of behavior, they differ on their level of scientific analysis of various dimensions of behavior.[3]

Behavioral sciences abstract empirical data to investigate the decision processes and communication strategies within and between organisms in a social system. This involves fields like psychology, social neuroscience ethology, and cognitive science.

In contrast, social sciences provide a perceptive framework to study the processes of a social system through impacts of social organization on structural adjustment of the individual and of groups. They typically include fields like sociology, economics, public health, anthropology, demography and political science.[1]

Many subfields of these disciplines cross the boundaries between behavioral and social sciences. For example, political psychology and behavioral economics use behavioral approaches, despite the predominant focus on systemic and institutional factors in the broader fields of political science and economics.

TOP

TOC Next

Categories of behavioural sciences

Behavioural sciences includes two broad categories: neural — *Information sciences* and social — *Relational sciences*.

Information processing sciences deals with information processing of stimuli from the social environment by cognitive entities in order to engage in decision making, social judgment and social perception for individual functioning and survival of organism in a social environment. These include psychology, cognitive science, psychobiology, neural networks, social cognition, social psychology, semantic networks, ethology, and social neuroscience.[4]

On the other hand, Relational sciences deals with relationships, interaction, communication networks, associations and relational strategies or dynamics between organisms or cognitive entities in a social system. These include fields like sociological social psychology, social networks, dynamic network analysis, agent-based model and microsimulation.

TOC Previous Next

Applications of behavioural sciences

Insights from several pure disciplines across behavioural sciences are explored by various applied disciplines and practiced in the context of everyday life and business. These applied disciplines of behavioural science include: organizational behavior, operations research, consumer behaviour and media psychology.

See also

- Behaviour
  - Human behaviour
- List of academic disciplines
- Science
  - Fields of science
    - Natural sciences
    - Social sciences
  - History of science
  - History of technology

TOC Previous Next

References

1. ^ [a] [b] Klemke, E. D., Hollinger, R., and Kline, A. D., (1980), Introduction to the book in 'Introductory Readings in the Philosophy of Science': Buffalo, New York, Prometheus Books p 11-12
2. ^ *"Definition of BEHAVIORAL SCIENCE"*. *www.merriam-webster.com. Retrieved 19 March 2018.*
3. ^ *"Definition of BEHAVIORAL SCIENCE"*. *www.Merriam-Webster.com. Retrieved 23 December 2017.*
4. ^ *"What are behavioral sciences? definition and meaning"*. *BusinessDictionary.com. Retrieved 23 December 2017.*

TOC Previous Next

Selected bibliography

- George Devereux: *From anxiety to method in the behavioral sciences*, The Hague, Paris. Mouton & Co, 1967
- *Fred N. Kerlinger (1979), Behavioral Research: A Conceptual Approach, New York: Holt, Rinehart & Winston, ISBN 0-03-013331-9*
- E.D. Klemke, R. Hollinger & A.D. Kline, (eds.) (1980). *Introductory Readings in the Philosophy of Science*. Prometheus Books, New York.
- Neil J. Smelser & Paul B. Baltes, eds. (2001). *International Encyclopedia of the Social & Behavioral Sciences*, 26 v. Oxford: Elsevier. ISBN 978-0-08-043076-8

External links

Categories:

- Behavioural sciences
- Cognitive science

This page was last edited on 10 June 2018, at 21:28.

Contents

Eye Tracking

Jump to navigation Jump to search
This article is about the study of eye movement. For the tendency to visually track potential prey, see eye-stalking.

Eye tracking is the process of measuring either the point of gaze (where one is looking) or the motion of an eye relative to the head. An **eye tracker** is a device for measuring eye positions and eye movement. Eye trackers are used in research on the visual system, in psychology, in psycholinguistics, marketing, as an input device for human-computer interaction, and in product design. There are a number of methods for measuring eye movement. The most popular variant uses video images from which the eye position is extracted. Other methods use search coils or are based on the electrooculogram.

TOP

TOC Next

History

In the 1800s, studies of eye movement were made using direct observations.

In 1879 in Paris, Louis Émile Javal observed that reading does not involve a smooth sweeping of the eyes along the text, as previously assumed, but a series of short stops (called fixations) and quick saccades.[1] This observation raised important questions about reading, questions which were explored during the 1900s: On which words do the eyes stop? For how long? When do they regress to already seen words?

Edmund Huey[2] built an early eye tracker, using a sort of contact lens with a hole for the pupil. The lens was connected to an aluminum pointer that moved in response to the movement of the eye. Huey studied and quantified regressions (only a small proportion of saccades are regressions), and he showed that some words in a sentence are not fixated.

The first non-intrusive eye-trackers were built by Guy Thomas Buswell in Chicago, using beams of light that were reflected on the eye and then recording them on film. Buswell made systematic studies into reading[3] and picture viewing.[4]

In the 1950s, Alfred L. Yarbus[5] did important eye tracking research and his 1967 book is often quoted. He showed that the task given to a subject has a very large influence on the subject's eye movement. He also wrote about the relation between fixations and interest:

> "All the records ... show conclusively that the character of the eye movement is either completely independent of or only very slightly dependent on the material of the picture and how it was made, provided that it is flat or nearly flat."[6] The cyclical pattern in the examination of pictures "is dependent on not only what is shown on the picture, but also the problem facing the observer and the information that he hopes to gain from the picture."[7]

> "Records of eye movements show that the observer's attention is usually held only by certain elements of the picture.... Eye movement reflects the human thought processes; so the observer's thought may be followed to some extent from records of eye movement (the thought accompanying the examination of the particular object). It is easy to determine from these records which elements attract the observer's eye (and, consequently, his thought), in what order, and how often."[6]

> "The observer's attention is frequently drawn to elements which do not give important information but which, in his opinion, may do so. Often an observer will focus his attention on elements that are unusual in the particular circumstances, unfamiliar, incomprehensible, and so on."[8]

> "... when changing its points of fixation, the observer's eye repeatedly returns to the same elements of the picture. Additional time spent on perception is not used to examine the secondary elements, but to reexamine the most important elements."[9]

In the 1970s, eye-tracking research expanded rapidly, particularly reading research. A good overview of the research in this period is given by Rayner.[13]

In 1980, Just and Carpenter[14] formulated the influential *Strong eye-mind hypothesis*, that "there is no appreciable lag between what is fixated and what is processed". If this hypothesis is correct, then when a subject looks at a word or object, he or she also thinks about it (process cognitively), and for exactly as long as the recorded fixation. The hypothesis is often taken for granted by researchers using eye-tracking. However, gaze-contingent techniques offer an interesting option in order to disentangle overt and covert attentions, to differentiate what is fixated and what is processed.

During the 1980s, the eye-mind hypothesis was often questioned in light of covert attention,[15][16] the attention to something that one is not looking at, which people often do. If covert attention is common during eye-tracking recordings, the resulting scan-path and fixation patterns would often show

not where our attention has been, but only where the eye has been looking, failing to indicate cognitive processing.

The 1980s also saw the birth of using eye-tracking to answer questions related to human-computer interaction. Specifically, researchers investigated how users search for commands in computer menus.[17] Additionally, computers allowed researchers to use eye-tracking results in real time, primarily to help disabled users.[18]

More recently, there has been growth in using eye tracking to study how users interact with different computer interfaces. Specific questions researchers ask are related to how easy different interfaces are for users.[19] The results of the eye tracking research can lead to changes in design of the interface. Yet another recent area of research focuses on Web development. This can include how users react to drop-down menus or where they focus their attention on a website so the developer knows where to place an advertisement.[20]

According to Hoffman,[21] current consensus is that visual attention is always slightly (100 to 250 ms) ahead of the eye. But as soon as attention moves to a new position, the eyes will want to follow.[22]

We still cannot infer specific cognitive processes directly from a fixation on a particular object in a scene.[23] For instance, a fixation on a face in a picture may indicate recognition, liking, dislike, puzzlement etc. Therefore, eye tracking is often coupled with other methodologies, such as introspective verbal protocols.

TOC Previous Next

Tracker types

Eye-trackers measure rotations of the eye in one of several ways, but principally they fall into three categories: (i) measurement of the movement of an object (normally, a special contact lens) attached to the eye; (ii) optical tracking without direct contact to the eye; and (iii) measurement of electric potentials using electrodes placed around the eyes.

TOC Previous Next

Eye-attached tracking

The first type uses an attachment to the eye, such as a special contact lens with an embedded mirror or magnetic field sensor, and the movement of the attachment is measured with the assumption that it does not slip significantly as the eye rotates. Measurements with tight-fitting contact lenses have provided extremely sensitive recordings of eye movement, and magnetic search coils are the method of choice for researchers studying the dynamics and underlying physiology of eye movement. This method allows the measurement of eye movement in horizontal, vertical and torsion directions.[24]

TOC Previous Next

Optical tracking

The second broad category uses some non-contact, optical method for measuring eye motion. Light, typically infrared, is reflected from the eye and sensed by a video camera or some other specially designed optical sensor. The information is then analyzed to extract eye rotation from changes in reflections. Video-based eye trackers typically use the corneal reflection (the first Purkinje image) and the center of the pupil as features to track over time. A more sensitive type of eye-tracker, the dual-Purkinje eye tracker,[25] uses reflections from the front of the cornea (first Purkinje image) and the back of the lens (fourth Purkinje image) as features to track. A still more sensitive method of tracking is to image features from inside the eye, such as the retinal blood vessels, and follow

these features as the eye rotates. Optical methods, particularly those based on video recording, are widely used for gaze-tracking and are favored for being non-invasive and inexpensive.

See also: Video-oculography

TOC Previous Next

Electric potential measurement

The third category uses electric potentials measured with electrodes placed around the eyes. The eyes are the origin of a steady electric potential field which can also be detected in total darkness and if the eyes are closed. It can be modelled to be generated by a dipole with its positive pole at the cornea and its negative pole at the retina. The electric signal that can be derived using two pairs of contact electrodes placed on the skin around one eye is called Electrooculogram (EOG). If the eyes move from the centre position towards the periphery, the retina approaches one electrode while the cornea approaches the opposing one. This change in the orientation of the dipole and consequently the electric potential field results in a change in the measured EOG signal. Inversely, by analysing these changes in eye movement can be tracked. Due to the discretisation given by the common electrode setup, two separate movement components – a horizontal and a vertical – can be identified. A third EOG component is the radial EOG channel,[26] which is the average of the EOG channels referenced to some posterior scalp electrode. This radial EOG channel is sensitive to the saccadic spike potentials stemming from the extra-ocular muscles at the onset of saccades, and allows reliable detection of even miniature saccades.[27]

Due to potential drifts and variable relations between the EOG signal amplitudes and the saccade sizes, it is challenging to use EOG for measuring slow eye movement and detecting gaze direction. EOG is, however, a very robust technique for measuring saccadic eye movement associated with gaze shifts and detecting blinks. Contrary to video-based eye-trackers, EOG allows recording of eye movements even with eyes closed, and can thus be used in sleep research. It is a very light-weight approach that, in contrast to current video-based eye-trackers, requires only

very low computational power; works under different lighting conditions; and can be implemented as an embedded, self-contained wearable system. [28] It is thus the method of choice for measuring eye movement in mobile daily-life situations and REM phases during sleep. The major disadvantage of EOG is its relatively poor gaze-direction accuracy compared to a video tracker. That is, it is difficult using EOG to determine with good accuracy exactly where a subject is looking, though the time of eye movements can be determined.

Technologies and techniques

The most widely used current designs are video-based eye-trackers. A camera focuses on one or both eyes and records eye movement as the viewer looks at some kind of stimulus. Most modern eye-trackers use the center of the pupil and infrared / near-infrared non-collimated light to create corneal reflections (CR). The vector between the pupil center and the corneal reflections can be used to compute the point of regard on surface or the gaze direction. A simple calibration procedure of the individual is usually needed before using the eye tracker.[29]

Two general types of infrared / near-infrared (also known as active light) eye-tracking techniques are used: bright-pupil and dark-pupil. Their difference is based on the location of the illumination source with respect to the optics. If the illumination is coaxial with the optical path, then the eye acts as a retroreflector as the light reflects off the retina creating a bright pupil effect similar to red eye. If the illumination source is offset from the optical path, then the pupil appears dark because the retroreflection from the retina is directed away from the camera.[30]

Bright-pupil tracking creates greater iris/pupil contrast, allowing more robust eye-tracking with all iris pigmentation, and greatly reduces interference caused by eyelashes and other obscuring features.[31] It also allows tracking in lighting conditions ranging from total darkness to very bright. Bright-pupil techniques are however not effective for tracking outdoors, as extraneous IR sources interfere with monitoring.[*citation needed*]

Another, less used, method is known as passive light. It uses visible light to illuminate, something which may cause some distractions to users.[30] Another challenge with this method is that the contrast of the pupil is less than in the active light methods, therefore, the center of iris is used for calculating the vector instead.[32] This calculation needs to detect the boundary of the iris and the white sclera (limbus tracking). It presents another challenge for vertical eye movements due to obstruction of eyelids.

[33]

Eye-tracking setups vary greatly: some are head-mounted, some require the head to be stable (for example, with a chin rest), and some function remotely and automatically track the head during motion. Most use a sampling rate of at least 30 Hz. Although 50/60 Hz is more common, today many video-based eye trackers run at 240, 350 or even 1000/1250 Hz, speeds needed in order to capture fixational eye movements or correctly measure saccade dynamics.

Eye movements are typically divided into fixations and saccades – when the eye gaze pauses in a certain position, and when it moves to another position, respectively. The resulting series of fixations and saccades is called a scanpath. Smooth pursuit describes the eye following a moving object. Fixational eye movements include micro saccades: small, involuntary saccades that occur during attempted fixation. Most information from the eye is made available during a fixation or smooth pursuit, but not during a saccade.[34] The central one or two degrees of the visual angle (that area of the visual field which falls on the fovea) provide the bulk of visual information; the input from larger eccentricities (the periphery) has less resolution and little to no colour, although contrast and movement is detected better in peripheral vision. Hence, the locations of fixations or smooth pursuit along a scanpath show what information loci on the stimulus were processed during an eye-tracking session. On average, fixations last for around 200 ms during the reading of linguistic text, and 350 ms during the viewing of a scene. Preparing a saccade towards a new goal takes around 200 ms.[*citation needed*]

Scanpaths are useful for analyzing cognitive intent, interest, and salience. Other biological factors (some as simple as gender) may affect the scanpath as well. Eye tracking in human–computer interaction (HCI) typically investigates the scanpath for usability purposes, or as a method of input in gaze-contingent displays, also known as gaze-based interfaces.[35]

Data presentation

Interpretation of the data that is recorded by the various types of eye-trackers employs a variety of software that animates or visually represents it, so that the visual behavior of one or more users can be graphically resumed. The video is generally manually coded to identify the AOIs(Area Of Interests) or recently using artificial intelligence. Graphical presentation is rarely the basis of research results, since they are limited in terms of what can be analysed - research relying on eye-tracking, for example, usually requires quantitative measures of the eye movement events and their parameters, The following visualisations are the most commonly used:

Animated representations of a point on the interface This method is used when the visual behavior is examined individually indicating where the user focused their gaze in each moment, complemented with a small path that indicates the previous saccade movements, as seen in the image.

Static representations of the saccade path This is fairly similar to the one described above, with the difference that this is static method. A higher level of expertise than with the animated ones is required to interpret this.

Heat maps An alternative static representation, used mainly for the agglomerated analysis of the visual exploration patterns in a group of users, differing from both methods explained before. In these representations, the ‘hot’ zones or zones with higher density designate where the users focused their gaze (not their attention) with a higher frequency. Heat maps are the best known visualization technique for eyetracking studies.[36]

Blind zones maps, or focus maps This method is a simplified version of the Heat maps where the visually less attended zones by the users are displayed clearly, thus allowing for an easier understanding of the most relevant information, that is to say, we are informed about which zones were not seen by the users.

Eye-tracking vs. gaze-tracking

Eye-trackers necessarily measure the rotation of the eye with respect to some frame of reference. This is usually tied to the measuring system. Thus, if the measuring system is head-mounted, as with EOG or a video-based system mounted to a helmet, then eye-in-head angles are measured. To deduce the line of sight in world coordinates, the head must be kept in a constant position or its movements must be tracked as well. In these cases, head direction is added to eye-in-head direction to determine gaze direction.

If the measuring system is table-mounted, as with scleral search coils or table-mounted camera (“remote”) systems, then gaze angles are measured directly in world coordinates. Typically, in these situations head movements are prohibited. For example, the head position is fixed using a bite bar or a forehead support. Then a head-centered reference frame is identical to a world-centered reference frame. Or colloquially, the eye-in-head position directly determines the gaze direction.

Some results are available on human eye movements under natural conditions where head movements are allowed as well.[37][38] The relative position of eye and head, even with constant gaze direction, influences neuronal activity in higher visual areas.[39]

Eye tracking in practice

A great deal of research has gone into studies of the mechanisms and dynamics of eye rotation, but the goal of eye- tracking is most often to estimate gaze direction. Users may be interested in what features of an image draw the eye, for example. It is important to realize that the eye-tracker does not provide absolute gaze direction, but rather can measure only changes in gaze direction. In order to know precisely what a subject is looking at, some calibration procedure is required in which the subject looks at a point or series of points, while the eye tracker records the value that corresponds to each gaze position. (Even those techniques that track features of the retina cannot provide exact gaze direction because there is no specific anatomical feature that marks the exact point where the visual axis meets the retina, if indeed there is such a single, stable point.) An accurate and reliable calibration is essential for obtaining valid and repeatable eye movement data, and this can be a significant challenge for non-verbal subjects or those who have unstable gaze.

Each method of eye-tracking has advantages and disadvantages, and the choice of an eye-tracking system depends on considerations of cost and application. There are offline methods and online procedures like AttentionTracking. There is a trade-off between cost and sensitivity, with the most sensitive systems costing many tens of thousands of dollars and requiring considerable expertise to operate properly. Advances in computer and video technology have led to the development of relatively low-cost systems that are useful for many applications and fairly easy to use. Interpretation of the results still requires some level of expertise, however, because a misaligned or poorly calibrated system can produce wildly erroneous data.

TOC Previous Next

Eye-tracking while driving a car in a difficult situation

The eye movement of two groups of drivers have been filmed with a special head camera by a team of the Swiss Federal Institute of

Technology: Novice and experienced drivers had their eye-movement recorded while approaching a bend of a narrow road. The series of images has been condensed from the original film frames[41] to show 2 eye fixations per image for better comprehension.

Each of these stills corresponds to approximately 0.5 seconds in realtime.

The series of images shows an example of eye fixations #9 to #14 of a typical novice and an experienced driver.

Comparison of the top images shows that the experienced driver checks the curve and even has Fixation No. 9 left to look aside while the novice driver needs to check the road and estimate his distance to the parked car.

In the middle images, the experienced driver is now fully concentrating on the location where an oncoming car could be seen. The novice driver concentrates his view on the parked car.

In the bottom image the novice is busy estimating the distance between the left wall and the parked car, while the experienced driver can use his peripheral vision for that and still concentrate his view on the dangerous point of the curve: If a car appears there, he has to give way, i. e. stop to the right instead of passing the parked car.[42]

TOC Previous Next

Eye-tracking of younger and elderly people while walking

While walking, elderly subjects depend more on foveal vision than do younger subjects. Their walking speed is decreased by a limited visual field, probably caused by a deteriorated peripheral vision.

Younger subjects make use of both their central and peripheral vision while walking. Their peripheral vision allows faster control over the process of walking.[43]

TOC Previous Next

Applications

A wide variety of disciplines use eye-tracking techniques, including cognitive science; psychology (notably psycholinguistics; the visual world paradigm); human-computer interaction (HCI); marketing research and medical research (neurological diagnosis). Specific applications include the tracking eye movement in language reading, music reading, human activity recognition, the perception of advertising, and the playing of sports.[44]

TOC Previous Next

Commercial applications

In recent years, the increased sophistication and accessibility of eye-tracking technologies have generated a great deal of interest in the commercial sector. Applications include web usability, advertising, sponsorship, package design and automotive engineering. In general, commercial eye-tracking studies function by presenting a target stimulus to a sample of consumers while an eye tracker is used to record the activity of the eye. Examples of target stimuli may include websites; television programs; sporting events; films and commercials; magazines and newspapers; packages; shelf displays; consumer systems (ATMs, checkout systems, kiosks); and software. The resulting data can be statistically analyzed and graphically rendered to provide evidence of specific visual patterns. By examining fixations, saccades, pupil dilation, blinks and a variety of other behaviors, researchers can determine a great deal about the effectiveness of a given medium or product. While some companies complete this type of research internally, there are many private companies that offer eye-tracking services and analysis.

One of the most prominent fields of commercial eye-tracking research is web usability.[*citation needed*] While traditional usability techniques are often quite powerful in providing information on clicking and scrolling

patterns, eye-tracking offers the ability to analyze user interaction between the clicks and how much time a user spends between clicks, thereby providing valuable insight into which features are the most eye-catching, which features cause confusion and which are ignored altogether. Specifically, eye-tracking can be used to assess search efficiency, branding, online advertisements, navigation usability, overall design and many other site components. Analyses may target a prototype or competitor site in addition to the main client site.

Eye-tracking is commonly used in a variety of different advertising media. Commercials, print ads, online ads and sponsored programs are all conducive to analysis with current eye-tracking technology. For instance in newspapers, eye-tracking studies can be used to find out in what way advertisements should be mixed with the news in order to catch the reader's eyes.[45] Analyses focus on visibility of a target product or logo in the context of a magazine, newspaper, website, or televised event. One example is an analysis of eye movements over advertisements in the Yellow Pages. The study focused on what particular features caused people to notice an ad, whether they viewed ads in a particular order and how viewing times varied. The study revealed that ad size, graphics, color, and copy all influence attention to advertisements. Knowing this allows researchers to assess in great detail how often a sample of consumers fixates on the target logo, product or ad. As a result, an advertiser can quantify the success of a given campaign in terms of actual visual attention.[46] Another example of this is a study that found that in a search engine results page, authorship snippets received more attention than the paid ads or even the first organic result.[47]

See also

- AttentionTracking
- Eye movement
- Eye movement in language reading
- Eye movement in music reading
- Eye Tracking Device
- Fovea
- Foveated imaging
- Gaze-contingency paradigm
- Marketing research
- Mouse-Tracking
- Peripheral vision
- Saccade
- visage SDK

Notes

1. ^ Reported in Huey 1908/1968.
2. ^ *Huey, Edmund. The Psychology and Pedagogy of Reading (Reprint). MIT Press 1968 (originally published 1908).*
3. ^ Buswell (1922, 1937)
4. ^ (1935)
5. ^ Yarbus 1967
6. ^ *a* *b* Yarbus 1967, p. 190
7. ^ Yarbus 1967, p. 194
8. ^ Yarbus 1967, p. 191
9. ^ Yarbus 1967, p. 193
10. ^ Hunziker, H. W. (1970). Visuelle Informationsaufnahme und Intelligenz: Eine Untersuchung über die Augenfixationen beim Problemlösen. Schweizerische Zeitschrift für Psychologie und ihre Anwendungen, 1970, 29, Nr 1/2 (english abstract: http://www.learning-systems.ch/multimedia/forsch1e.htm)
11. ^ http://www.learning-systems.ch/multimedia/eye movements problem solving.swf
12. ^ http://www.learning-systems.ch/multimedia/forsch1e.htm
13. ^ Rayner (1978)
14. ^ Just and Carpenter (1980)
15. ^ Posner (1980)
16. ^ Wright & Ward (2008)
17. ^ [1]
18. ^ [2], [3]
19. ^ [4], [5], [6]
20. ^ [7]
21. ^ Hoffman 1998
22. ^ *Deubel, Heiner (1996). "Saccade target selection and object recognition: Evidence for a common attentional mechanism". Vision Research.* ***36****: 1827–1837. doi:10.1016/0042-6989(95)00294-4. PMID 8759451.*
23. ^ Holsanova 2007
24. ^ David A. Robinson: A method of measuring eye movement using a

scleral search coil in a magnetic field, IEEE Transactions on Bio-Medical Electronics, October 1963, 137–145 (PDF)

25. ^ *Crane, H.D.; Steele, C.M. (1985). "Generation-V dual-Purkinje-image eyetracker". Applied Optics. **24** (4): 527–537. doi:10.1364/AO.24.000527.*
26. ^ Elbert, T., Lutzenberger, W., Rockstroh, B., Birbaumer, N., 1985. Removal of ocular artifacts from the EEG. A biophysical approach to the EOG. Electroencephalogr Clin Neurophysiol 60, 455-463.
27. ^ *Keren, A.S.; Yuval-Greenberg, S.; Deouell, L.Y. (2010). "Saccadic spike potentials in gamma-band EEG: Characterization, detection and suppression". NeuroImage. **49**: 2248–2263. doi:10.1016/j.neuroimage.2009.10.057. PMID 19874901.*
28. ^ *Bulling, A.; Roggen, D.; Tröster, G. (2009). "Wearable EOG goggles: Seamless sensing and context-awareness in everyday environments". Journal of Ambient Intelligence and Smart Environments (JAISE). **1** (2): 157–171. doi:10.3233/AIS-2009-0020.*
29. ^ *Witzner Hansen, Dan; Qiang Ji (March 2010). "In the Eye of the Beholder: A Survey of Models for Eyes and Gaze". IEEE Trans. Pattern Anal. Mach. Intell. **32** (3): 478–500. doi:10.1109/tpami.2009.30.*
30. ^ ***a*** ***b*** *Gneo, Massimo; Schmid, Maurizio; Conforto, Silvia; D'Alessio, Tommaso (2012). "A free geometry model-independent neural eye-gaze tracking system". Journal of NeuroEngineering and Rehabilitation. **9** (1): 82. doi:10.1186/1743-0003-9-82.*
31. ^ The Eye: A Survey of Human Vision; Wikimedia Foundation
32. ^ *Sigut, J; Sidha, SA (February 2011). "Iris center corneal reflection method for gaze tracking using visible light". IEEE transactions on bio-medical engineering. **58** (2): 411–9. doi:10.1109/tbme.2010.2087330. PMID 20952326.*
33. ^ *Hua, H; Krishnaswamy, P; Rolland, JP (15 May 2006). "Video-based eyetracking methods and algorithms in head-mounted displays". Optics Express. **14** (10): 4328–50. doi:10.1364/oe.14.004328. PMID 19516585.*
34. ^ *Purves, D; st al. (2001). Neuroscience, 2d ed. Sunderland (MA): Sinauer Assocs. p. What Eye Movements Accomplish.*
35. ^ Majaranta, P., Aoki, H., Donegan, M., Hansen, D.W., Hansen, J.P., Hyrskykari, A., Räihä, K.J., *Gaze Interaction and Applications of Eye*

Tracking: Advances in Assistive Technologies, IGI Global, 2011

36. ^ Nielsen, Jakob. Pernice, Kara. (2010). " [8] Eyetracking Web Usability." New Rideres Publishing. p. 11. ISBN 0-321-49836-4. Google Book Search. Retrieved on October 28, 2013.
37. ^ *Einhäuser, W; Moeller, GU; Schumann, F; Conradt, J; Vockeroth, J; Bartl, K; Schneider, E; König, P (2009). "Eye-head coordination during free exploration in human and cat". Annals of the New York Academy of Sciences.* ***1164****: 353–366. doi:10.1111/j.1749-6632.2008.03709.x.*
38. ^ Einhäuser W, Schumann F, Bardins S, Bartl K, Böning G, Schneider E and König P (2007). Human eye-head co-ordination in natural exploration. Network: Computation in Neural Systems 18:267-297. Electronical publication: doi: 10.1080/09548980701671094
39. ^ *Andersen, R. A.; Bracewell, R. M.; Barash, S.; Gnadt, J. W.; Fogassi, L. (1990). "Eye position effects on visual, memory, and saccade-related activity in areas LIP and 7a of macaque". Journal of Neuroscience.* ***10*** *(4): 1176–1196.*
40. ^ Hans-Werner Hunziker, (2006) Im Auge des Lesers: foveale und periphere Wahrnehmung - vom Buchstabieren zur Lesefreude [In the eye of the reader: foveal and peripheral perception - from letter recognition to the joy of reading] Transmedia Stäubli Verlag Zürich 2006 ISBN 978-3-7266-0068-6 Based on data from:Cohen, A. S. (1983). Informationsaufnahme beim Befahren von Kurven, Psychologie für die Praxis 2/83, Bulletin der Schweizerischen Stiftung für Angewandte Psychologie
41. ^ Cohen, A. S. (1983). Informationsaufnahme beim Befahren von Kurven, Psychologie für die Praxis 2/83, Bulletin der Schweizerischen Stiftung für Angewandte Psychologie
42. ^ Pictures from: Hans-Werner Hunziker, (2006) Im Auge des Lesers: foveale und periphere Wahrnehmung – vom Buchstabieren zur Lesefreude [In the eye of the reader: foveal and peripheral perception – from letter recognition to the joy of reading] Transmedia Stäubli Verlag Zürich 2006 ISBN 978-3-7266-0068-6
43. ^ Itoh N, Fukuda T. (2002) Comparative study of eye movement in extent of central and peripheral vision and use by young and elderly walkers. *Percept Mot Skills.* 2002 Jun;94(3 Pt 2):1283–91

44. ^ See, e.g., newspaper reading studies.
45. ^ "Eye Tracking Study: The New York Times vs. The Wall Street Journal"
46. ^ *Lohse, Gerald; Wu, D. J. (1 February 2001). "Eye Movement Patterns on Chinese Yellow Pages Advertising". Electronic Markets.* ***11*** *(2): 87–96. doi:10.1080/101967801300197007.*
47. ^ "Eye Tracking Study: The Importance of Using Google Authorship in Search Results" [9]

References

- Adler, FH; Fliegelman (1934). "Influence of fixation on the visual acuity". *Arch. Ophthalmology*. **12**: 475–483. doi: 10.1001/archopht.1934.00830170013002.
- Buswell, G.T. (1922). Fundamental reading habits: A study of their development. Chicago, IL: University of Chicago Press.
- Buswell G.T. (1935). How People Look at Pictures. Chicago: Univ. Chicago Press 137–55. Hillsdale, NJ: Erlbaum
- Buswell, G.T. (1937). How adults read. Chicago, IL: University of Chicago Press.
- Carpenter, Roger H.S.; Movements of the Eyes (2nd ed.). Pion Ltd, London, 1988. ISBN 0-85086-109-8.
- Cornsweet, TN; Crane, HD (1973). "Accurate two-dimensional eye tracker using first and fourth Purkinje images". *J Opt Soc Am*. **63**: 921–8. doi: 10.1364/josa.63.000921.
- Cornsweet, TN (1958). "New technique for the measurement of small eye movements". *JOSA*. **48**: 808–811. doi: 10.1364/josa.48.000808.
- Deubel, H.; Schneider, W.X. (1996). "Saccade target selection and object recognition: Evidence for a common attentional mechanism". *Vision Research*. **36**: 1827–1837. doi: 10.1016/0042-6989(95)00294-4. PMID 8759451.
- Duchowski, A. T., "A Breadth-First Survey of Eye Tracking Applications", Behavior Research Methods, Instruments, & Computers (BRMIC), 34(4), November 2002, pp. 455–470.
- Eizenman, M; Hallett, PE; Frecker, RC (1985). "Power spectra for ocular drift and tremor". *Vision Res*. **25**: 1635–40. doi: 10.1016/0042-6989(85)90134-8.
- Ferguson RD (1998). Servo tracking system utilizing phase-sensitive detection of reflectance variations. US Patent # 5,767,941
- Hammer, DX; Ferguson, RD; Magill, JC; White, MA; Elsner, AE; Webb, RH (2003). "Compact scanning laser ophthalmoscope with high-speed retinal tracker". *Appl Opt*. **42**: 4621–32. doi: 10.1364/ao.42.004621.
- Hoffman, J. E. (1998). Visual attention and eye movements. In H. Pashler (ed.), Attention (pp. 119–154). Hove, UK: Psychology Press.
- Holsanova, J. (forthcoming) Picture viewing and picture descriptions, Benjamins.
- Huey, E.B. (1968). The psychology and pedagogy of reading. Cambridge, MA: MIT Press. (Originally published 1908)
- Jacob, R. J. K. & Karn, K. S. (2003). Eye Tracking in Human-Computer Interaction and Usability Research: Ready to Deliver the Promises. In R. Radach, J. Hyona, & H. Deubel (eds.), The mind's eye: cognitive and applied aspects of eye movement research (pp. 573–605). Boston: North-

Holland/Elsevier.

- Just MA, Carpenter PA (1980) A theory of reading: from eye fixation to comprehension. Psychol Rev 87:329–354
- Liechty, J, Pieters, R, & Wedel, M. (2003). The Representation of Local and Global Exploration Modes in Eye Movements through Bayesian Hidden Markov Models. Psychometrika, 68 (4), 519–542.
- Mulligan, JB, (1997). Recovery of Motion Parameters from Distortions in Scanned Images. Proceedings of the NASA Image Registration Workshop (IRW97), NASA Goddard Space Flight Center, MD
- Ott, D; Daunicht, WJ (1992). "Eye movement measurement with the scanning laser ophthalmoscope". *Clin. Vision Sci.* **7**: 551–556.
- Pirri, F., Pizzoli, M., Rudi, A, (2011). A general method for the point of regard estimation in 3D space. Computer Vision and Pattern Recognition (CVPR), 2011 IEEE Conference on, 921-928. doi: 10.1109/CVPR.2011.5995634
- Posner, M. I. (1980). "Orienting of attention". *Quarterly Journal of Experimental Psychology*. **32**: 3–25. doi: 10.1080/00335558008248231. PMID 7367577.
- Rayner, K (1978). "Eye movements in reading and information processing". *Psychological Bulletin*. **85**: 618–660. doi: 10.1037/0033-2909.85.3.618. PMID 353867.
- Rayner, K (1998). "Eye movements in reading and information processing: 20 years of research". *Psychological Bulletin*. **124**: 372–422. doi: 10.1037/0033-2909.124.3.372. PMID 9849112.
- Riggs, LA; Armington, JC; Ratliff, F (1954). "Motions of the retinal image during fixation". *JOSA*. **44**: 315–321. doi: 10.1364/josa.44.000315.
- Riggs, L. A.; Niehl, E. W. (1960). "Eye movements recorded during convergence and divergence". *J Opt Soc Am*. **50**: 913–920. doi: 10.1364/josa.50.000913.
- Riju Srimal, Jorn Diedrichsen, Edward B. Ryklin, and Clayton E. Curtis. "Obligatory adaptation of saccade gains. J Neurophysiol. 2008 Mar;99(3):1554-8
- Robinson, D. A. A method of measuring eye movement using a scleral search coil in a magnetic field. *IEEE Trans. Biomed. Eng.* vol. BME-l0, pp. 137–145, 1963
- Wright, R.D., & Ward, L.M. (2008). Orienting of Attention. New York. Oxford University Press.
- Yarbus, A. L. (1967), *Eye Movements and Vision*, New York: Plenum. (Originally published in Russian 1962)

TOC Previous

Commercial eye tracking

- Bojko, A (2006). "Using Eye Tracking to Compare Web Page Designs: A Case Study". *Journal of Usability Studies*. **1** (3).
- Bojko, A.; Stephenson, A. (2005). "It's All in the Eye of the User: How eye tracking can help answer usability questions". *User Experience*. **4** (1).
- Chandon, Pierre, J. Wesley Hutchinson, and Scott H. Young (2001), Measuring Value of Point-of-Purchase Marketing with Commercial Eye-Tracking Data. [10]
- Duchowski, A. T. (2002). "A Breadth-First Survey of Eye Tracking Applications". *Behavior Research Methods, Instruments, & Computers (BRMIC)*. **34** (4): 455–470. doi: 10.3758/bf03195475.
- National Highway Traffic Safety Administration. (n.d.) Retrieved July 9, 2006, from [11]
- Pieters, R.; Wedel, M.; Zhang, J. (2007). "Optimal Feature Advertising Under Competitive Clutter". *Management Science*. **51** (11): 1815–1828. doi: 10.1287/mnsc.1070.0732.
- Pieters, R.; Wedel, M. (2007). "Goal Control of Visual Attention to Advertising: The Yarbus Implication". *Journal of Consumer Research*. **34**: 224–233. doi: 10.1086/519150.
- Pieters, R.; Wedel, M. (2004). "Attention Capture and Transfer by elements of Advertisements". *Journal of Marketing*. **68** (2): 36–50. doi: 10.1509/jmkg.68.2.36.27794.
- Thomas RECORDING GmbH, high-speed Eye Tracking Systems for neuro-scientific purposes [12]
- Weatherhead, James (2005). "Eye on the Future". *British Computer Society, ITNOW Future of Computing*. **47** (6): 32–33. doi: 10.1093/itnow/bwi127.
- Wedel, M.; Pieters, R. (2000). "Eye fixations on advertisements and memory for brands: a model and findings". *Marketing Science*. **19** (4): 297–312. doi: 10.1287/mksc.19.4.297.11794.
- Wittenstein, Jerran. (2006). EyeTracking sees gold in its technology. [Electronic Version]. San Diego Source, The Daily Transcript, April, 3rd, 2006. [13]

Categories: Attention | Cognitive science | Eye | History of human–computer interaction | Market research | Multimodal interaction | Promotion and marketing communications | Usability | Vision | Web design

This page was last edited on 5 June 2018, at 19:40.

Back to main TOC

Contents

Embodied Cognition

Embodied cognition is the theory that many features of cognition, whether human or otherwise, are shaped by aspects of the entire body of the organism. The features of cognition include high level mental constructs (such as concepts and categories) and performance on various cognitive tasks (such as reasoning or judgment). The aspects of the body include the motor system, the perceptual system, bodily interactions with the environment (situatedness) and the assumptions about the world that are built into the structure of the organism.

The embodied mind thesis challenges other theories, such as cognitivism, computationalism, and Cartesian dualism.[1][2] It is closely related to the extended mind thesis, situated cognition and enactivism. The modern version depends on insights drawn from recent research in psychology, linguistics, cognitive science, dynamical systems, artificial intelligence, robotics, animal cognition, plant cognition and neurobiology.

Embodiment thesis

In philosophy, embodied cognition holds that an agent's cognition is strongly influenced by aspects of an agent's body beyond the brain itself.[1] In their proposal for an enactive approach to cognition Varela *et al.* defined "embodied":[3]

> — Eleanor Rosch, Evan Thompson, Francisco J. Varela: *The Embodied Mind: Cognitive Science and Human Experience* pages 172–173

The Varela enactive definition is broad enough to overlap the views of extended cognition and situated cognition, and indeed, these ideas are not always carefully separated.[4] For example, according to Michael Dawson, the relationship is tangled:[5]

> — Michael Dawson: *Degrees of embodiment*; The Routledge Handbook of Embodied Cognition, page 62

Some authors explain the dependence of cognition upon the body and its environmental interactions by saying cognition in real biological systems is not an end in itself but is constrained by the system's goals and capacities. However, they argue, such constraints do not mean cognition is set by adaptive behavior (or autopoiesis) alone, but cognition requires “*some* kind of information processing...the transformation or communication of incoming information”, the acquiring of which involves "exploration and modification of the environment".[6]

> — Marcin Miłkowski: *Explaining the Computational Mind*, p. 4

The separation of embodied cognition from extended cognition and situated cognition can be based upon the *embodiment thesis*, a narrower view of embodiment than that of Varela *et al.* or that of Dawson:[1]

> —RA Wilson and L Foglia, *Embodied Cognition* in the Stanford Encyclopedia of Philosophy

This thesis omits direct mention of some aspects of the "more encompassing biological, psychological and cultural context" included by Varela *et al.* The *Extended* mind thesis, in contrast with the *Embodiment* thesis, limits cognitive processing neither to the brain nor even to the body, but extends it outward into the agent's world.[1][7] *Situated* cognition emphasizes that this extension is not just a matter of including resources outside the head, but stresses the role of probing and modifying interaction with the agent's world.[8]

Philosophical background

In his *Universal Natural History and Theory of Heaven* (1755).[9] philosopher Immanuel Kant advocated a view of the mind–body problem and the subject–object problem with parallels to the embodied view.[10] Some difficulties with this interpretation of Kant include (i) the view that Kant holds the empirical, and specifically knowledge of the body, cannot support *a priori* transcendental claims,[11] and (ii) the view that Kant holds that transcendental philosophy, although charged with the responsibility of explaining how we can have empirical knowledge, is not itself empirical.[12]

José Ortega y Gasset, George Santayana, Miguel de Unamuno, Maurice Merleau-Ponty, Martin Heidegger and others in the broadly existential tradition have proposed philosophies of mind influencing the development of the modern 'embodiment' thesis.[13]

The embodiment movement in artificial intelligence has fueled the embodiment argument in philosophy and a revised view of ethology:[14]

> —Horst Hendriks-Jansen *Catching Ourselves in the Act*, p. 10

These developments have also given emotions a new status in philosophy of mind as an indispensable constituent, rather than a non-essential addition to rational intellectual thought. In philosophy of mind, the idea that cognition is embodied is sympathetic with other views of cognition such as situated cognition or externalism. This is a radical move towards a total re-localization of mental processes out of the neural domain.[15]

Connections with the sciences

Embodied cognition is a topic of research in social and cognitive psychology, covering issues such as social interaction and decision-making.[16] Embodied cognition reflects the argument that the motor system influences our cognition, just as the mind influences bodily actions. For example, when participants hold a pencil in their teeth engaging the muscles of a smile, they comprehend pleasant sentences faster than unpleasant ones, while holding a pencil between their nose and upper lip to engage the muscles of a frown has the reverse effect.[17]

George Lakoff (a cognitive scientist and linguist) and his collaborators (including Mark Johnson, Mark Turner, and Rafael E. Núñez) have written a series of books promoting and expanding the thesis based on discoveries in cognitive science, such as conceptual metaphor and image schema.[18]

Robotics researchers such as Rodney Brooks, Hans Moravec and Rolf Pfeifer have argued that true artificial intelligence can only be achieved by machines that have sensory and motor skills and are connected to the world through a body.[19] The insights of these robotics researchers have in turn inspired philosophers like Andy Clark and Horst Hendriks-Jansen.[20]

Neuroscientists Gerald Edelman, António Damásio and others have outlined the connection between the body, individual structures in the brain and aspects of the mind such as consciousness, emotion, self-awareness and will.[21] Biology has also inspired Gregory Bateson, Humberto Maturana, Francisco Varela, Eleanor Rosch and Evan Thompson to develop a closely related version of the idea, which they call enactivism.[22] The motor theory of speech perception proposed by Alvin Liberman and colleagues at the Haskins Laboratories argues that the identification of words is embodied in perception of the bodily movements by which spoken words are made.[23]

[24][25][26][27] In related work at Haskins, Paul Mermelstein, Philip Rubin, Louis Goldstein, and colleagues developed articulatory synthesis tools for computationally modeling the physiology and aeroacoustics of the vocal tract, demonstrating how cognition and perception of speech can be shaped by biological constraints. This was extended into the audio-visual domain by the "talking heads" approach of Eric Vatikiotis-Bateson, Rubin, and other colleagues.

More detail is provided in the sections that follow.

TOC Previous Next

Visual search

One embodied cognition study shows that action intention can affect processing in visual search, with more orientation errors for pointing than for grasping.[28] Participants either pointed to or grasped target objects of 2 colors and 2 orientations (45° and 135°). There were randomized numbers of distractors as well (0, 3, 6, or 9), which differed from the target in color, orientation, or both. A tone sounded to inform participants which target orientation to find. Participants kept their eyes on a fixation point until it turned from red to the target color. The screen then lit up and the participants searched for the target, either pointing to it or grasping it (depending on the block). There were 2 blocks for pointing and 2 for grasping, with the order counterbalanced. Each block had 64 trials.[28]

Results from the experiment show that accuracy decreases with an increase in the number of distractors.[28] Overall, participants made more orientation errors than color errors.[28] There was no main effect of accuracy between the pointing and grasping conditions, but participants made significantly fewer orientation errors in the grasping condition than in the pointing condition.[28] Color errors were the same in both conditions.[28] Because orientation is important in grasping an object, these results fit with the researchers' hypothesis that the plan to grasp an object will aid in orientation accuracy.[28] This supports embodied cognition because action intention (planning to grasp an object) can affect visual processing of task-relevant information (orientation).[28]

TOC Previous Next

Distance perception

Internal states can affect distance perception, which relates to embodied cognition.[29] Researchers randomly assigned college student participants

to high-choice, low-choice, and control conditions. The high-choice condition signed a “freedom of choice” consent form indicating their decision to wear a Carmen Miranda costume and walk across a busy area of campus. Low-choice participants signed an “experimenter choice” consent form, indicating the experimenter assigned the participant to wear the costume. A control group walked across campus but did not wear a costume. At the conclusion of the experiment, each participant completed a survey which asked them to estimate the distance they walked.[29]

The high-choice participants perceived the distance walked as significantly shorter than participants in the low-choice and control groups, even though they walked the same distance.[29] The manipulation caused high-choice participants to feel responsible for the choice to walk in the embarrassing costume.[29] This created cognitive dissonance, which refers to a discrepancy between attitudes and behaviors.[29] High-choice participants reconciled their thoughts and actions by perceiving the distance as shorter.[29] These results show the ability of internal states to affect perception of physical distance moved, which illustrates the reciprocal relationship of the body and mind in embodied cognition.[29]

Perspective

Researchers have found that when making judgements about objects in photographs, people will take the perspective of a person in the picture instead of their own.[30] They showed college undergraduate participants 1 of 3 photographs and asked where 1 object in the picture was compared to the other object. For example, if the 2 objects were an apple and a banana, the participants would have to respond to a question about the location of the apple compared to the banana. The photographs either had no person, a person looking at the object, in this case the banana, or a person reaching for the banana. The photograph and question appeared in a larger set of questionnaires not related to the study.[30]

Results show that participants who viewed photographs that included a person were significantly more likely to respond from another's perspective

than those who saw photographs with no person.[30] There were no differences in perspective of responses for the person looking versus reaching.[30] Participants who saw the scene without a person were significantly more likely to respond from their own perspective.[30] This means that the presence of a person in the photograph affected the perspective used even though the question focused solely on the two objects.[30] The researchers state that these results suggest *disembodied* cognition, in which the participants put themselves into the body of the person in the photograph.[30]

Language comprehension

See also: Embodied language processing

Some researchers extend embodied cognition to include language.[31][16] They describe language as a tool that aids in broadening our sense of body.[16] For instance, when asked to identify “this” object, participants most often choose an object near to them.[16] Conversely, when asked to identify “that” object, participants choose an object further away from them.[16] Language allows us to distinguish between distances in more complex ways than the simple perceptual difference between near and far objects.[16]

The motor system is involved in language comprehension, in this case when sentences were performable by a human, there was a change in participants' overall movement of a pendulum.[32] Researchers performed an experiment in which college undergraduate participants swung a pendulum while completing a "sentence judgement task." Participants would swing the pendulum with both hands for 10 seconds before a prompt and then a sentence would appear on the screen until the participant responded. In the control condition, participants swung the pendulum without performing the "sentence judgement task." Each trial had half "plausible" and half "implausible" sentences. The "plausible" sentences made sense semantically, while the "implausible" ones did not. The "performable" sentences could be performed by a human, while the

"inanimate" sentences could not. Participants responded by saying "yes" to the "plausible" sentences.[32]

Results show a significant "relative phase shift," or overall change in movement of the swinging pendulum, for the "performable" sentences.[32] This change did not occur for "inanimate" sentences or the control condition.[32] The researchers did not expect an overall phase shift, instead they expected a change in the variability of movement, or the "standard deviation of relative phase shift."[32] Although not entirely expected, these results support embodied cognition and show that the motor system is involved in the understanding of language.[32] The researchers suggest that the nature of this relationship needs to be further studied to determine the exact correlation this task has to bi-manual motor movements.[32]

Embodiment effects emerge in the way in which people of different sex and temperament perceive verbal material, such as common adjectives and abstract and neutral nouns. Trofimova, who first described this phenomenon in her experiments, called it "projection through capacities". This phenomenon emerges when people's lexical perception depends upon their capacities to handle the events; when their information processing registers mostly those aspects of objects or of a situation that they can properly react to and deal with according to their inherent capacities.[33][34][35] For example, in these studies males with stronger motor-physical endurance estimated abstractions describing people-, work/reality- and time-related concepts in more positive terms than males with a weaker endurance. Females with stronger social or physical endurance estimated social attractors in more positive terms than weaker females. Both male and female temperament groups with higher sociability showed a universal positive bias in their estimations of neutral words, especially for social and work/reality-related concepts, in comparison to participants with lower sociability. Capacities related to the tempo of activities also appeared to impact the perception of lexical material: men with faster motor-physical tempo estimated neutral, abstract time-related concepts significantly in more positive terms than men with slower tempo.

TOC Previous Next

Memory

A study examining memory and embodied cognition illustrates that people remember more of the gist of a story when they physically act it out.[36] Researchers divided female participants randomly into 5 groups, which were "Read Only," "Writing," "Collaborative Discussion," "Independent Discussion," and " Improvisation ." All participants received a monologue about teen addiction and were told to pay attention to details about the character and action in the monologue. Participants were given 5 minutes to read the monologue twice, unaware of a future recall test. In the "Read Only" condition participants filled out unrelated questionnaires after reading the monologue. In the "Writing" condition participants responded to 5 questions about the story from the perspective of the character in the monologue. They had 6 minutes to answer each question. In the "Collaborative Discussion" condition participants responded from the character's perspective to the same questions as the "Writing" group, but in groups of 4 or 5 women. They were also given 6 minutes per question and everyone participated in answering each question. The "Independent Discussion" condition was the same as the "Collaborative Discussion," except 1 person answered each question. In the "Improvisation" condition participants acted out 5 scenes from the monologue in groups of 5 women. The researchers suggest that this condition involves embodied cognition and will produce better memory for the monologue. Every participant played the main character and a supporting character once. Participants were given short prompts from lines in the monologue, which were excluded from the memory test. Participants had 2 minutes to choose characters and 4 minutes for improvisations. The recall test was the monologue with 96 words or phrases missing. Participants had to fill in the blanks as accurately as possible.[36]

Researchers gave the recall test to a group who did not read the monologue. They scored significantly lower than the other groups, which indicated that guessing was not easy.[36] In coding the answers to the recall test, exact words were labeled "Verbatim", and correct content but varied wording was labeled "Gist". The combination of "Verbatim" and "Gist" was called "Total Memory." The "Improvisational" group had more "Gist"

memories than any other group and had more "Total Memory" than both of the discussion groups.[36] The results fit the researchers' hypothesis that the "Improvisational" group would remember more because they actively rehearsed the information from the monologue.[36] Although other groups had also elaborately encoded the information, the "Improvisation" group remembered significantly more than the discussion groups and marginally more than the "Reading Only" and "Writing" groups.[36] Simply experiencing the monologue in an active way aids in remembering the "Gist."[36] There were no differences across groups for "Verbatim" memory, which they suggest could take longer than the limited time during the experiment to develop.[36]

TOC Previous Next

Reasoning

A series of experiments demonstrated the interrelation between motor experience and high-level reasoning. For example, although most individuals recruit visual processes when presented with spatial problems such as mental rotation tasks[37] motor experts favor motor processes to perform the same tasks, with higher overall performance.[38] A related study showed that motor experts use similar processes for the mental rotation of body parts and polygons, whereas non-experts treated these stimuli differently.[39] These results were not due to underlying confounds, as demonstrated by a training study which showed mental rotation improvements after a one-year motor training, compared with controls.[40] Similar patterns were also found in working memory tasks, with the ability to remember movements being greatly disrupted by a secondary verbal task in controls and by a motor task in motor experts, suggesting the involvement of different processes to store movements depending on motor experience, namely verbal for controls and motor for experts.[41]

Approach and avoidance

In research focused on the approach and avoidance effect, people showed an approach effect for positive words.[42] In the "positive toward condition," participants moved positive words toward the center of the screen and negative words away. In the "negative toward condition," participants moved negative words toward the center and positive words away. Participants were given feedback about their accuracy at the end of each of the 4 experimental blocks. In the first experiment the word at the center of the screen had a positive valence, while in the second experiment the central word had a negative valence. In the third experiment, the center of the screen had an empty box.[42]

As predicted, in the first experiment participants in the "positive toward condition" responded significantly faster than those in the "negative toward condition."[42] This fits the approach/avoidance effect in embodied

cognition, which states that people are faster to approach positive things and avoid negative ones.[42] In the second experiment, researchers expected participants in the "negative toward condition" to be faster, yet those in the "positive toward condition" responded significantly faster.[42] Although effects were smaller in the third experiment, participants in the "positive toward condition" were still faster.[42] Overall, people were faster in the "positive toward condition," regardless of the valence of the central word. Despite mixed results regarding the researchers' expectations, they maintain that the motor system is important in processing higher level representations such as the action goal.[42] In this study, participants showed strong approach effects in the "positive toward condition," which supports embodied cognition.[42]

As part of a larger study, researchers separated participants into 5 groups with different instructions.[43] In the "approach" condition, participants were instructed to imagine physically moving the product toward them, but in the "avoid" condition, participants had to imagine moving the product away from them. In the "control" condition, participants were instructed to simply observe the product. The "correction" condition involved the same instructions as the approach condition, except participants were told that the body can affect judgment. In the "approach information" condition, participants had to list 5 reasons why they would obtain the product. After viewing a picture of an aversive product, participants rated on a scale of 1 to 7 how desirable the product was and how much they approached of or avoided the product. They also provided how much they would pay for the product.[43]

An approach/avoidance effect was found in relation to product evaluation.[43] Participants in the "approach" condition liked the aversive product significantly more and would pay more for it. There were no differences between the "avoidance," "control," "correction," and "approach information" conditions. Simulation of approach can affect liking and willingness to pay for a product, but the effect can be reversed if the person knows about this influence.[43] This supports embodied cognition.[43]

Self-regulation

As part of a larger study, one experiment randomly assigned college undergraduates to 2 groups.[44] In the "muscle-firming" condition participants grasped a pen in their hand, while in the "control" condition participants held the pen in their fingers. The participants were then asked to fill out donations to Haiti for the Red Cross in sealed envelopes. They were told to return the envelope regardless of whether they donated. They also filled out questionnaires about their feelings about the Red Cross, their tendency to donate, their feelings about Haiti, what they thought the purpose of the study was, etc.[44]

Significantly more participants in the "muscle-firming" condition than in the "control" condition donated money.[44] Condition did not affect the actual amount donated when participants chose to donate. As the researchers predicted, the "muscle-firming" condition helped participants get over their physical aversion to viewing the devastation in Haiti and spend money. Muscle-firming in this experiment may also be related to an increase in self-control, suggesting embodied cognition can play a role in self-regulation.[44]

Another set of studies was conducted by Shalev (2014), indicating that exposure to physical or conceptual thirst or dryness-related cues influence perceived energy and reduce self-regulation. In Study 1, participants primed with dryness-related concepts reported greater physical thirst and tiredness and lower subjective vitality. In Study 2, participants who were physically thirstywere less persistent in investing effort in an unsolvable anagram task. In Study 3, images of arid land influenced time preference regarding when to begin preparation to make a monetary investment. Finally, in Studies 4a and 4b, exposure to the names of dryness-related products influenced impressions of the vitality of a target person.[45]

Some suggest that the embodied mind serves self-regulatory processes by combining movement and cognition to reach a goal.[46] Thus, the embodied mind has a facilitative effect. Some judgments, such as the emotion of a face, are detected more quickly when a participant mimics the facial expression that is being evaluated.[29] Individuals holding a pen in their mouths to freeze their facial muscles and make them unable to mimic the expression were less able to judge emotions. Goal-relevant actions may be encouraged by embodied cognition, as evidenced by the automated approach and avoidance of certain environmental cues.[29] Embodied cognition is also influenced by the situation. If one moves in a way previously associated with danger, the body may require a greater level of information processing than if the body moves in a way associated with a benign situation.[46]

Social psychology

Some social psychologists examined embodied cognition and hypothesized that embodied cognition would be supported by embodied rapport.[47] Embodied rapport would be demonstrated by pairs of same-sex strangers using Aron's paradigm, which instructs participants to alternate asking certain questions and to progressively self-disclose. The researchers predicted that participants would mimic each other's movements, reflecting embodied cognition. Half the participants completed a control task of reading and editing a scientific article, while half the participants completed a shortened version of Aron's self-disclosure paradigm.[47]

There is a significant correlation between self-disclosure and positive emotions towards the other participant.[47] Participants randomly assigned to the self-disclosure task displayed more behavioral synchrony (rated by independent judges watching the tapes of each condition on mute) and reported more positive emotions than the control group.[47] Since bodily movements influence the psychological experience of the task, the relationship between self-disclosure and positive feelings towards one's partner may be an example of embodied cognition.[47]

☰ TOC | ← Previous | Next →

Evolutionary view

Embodied cognition may also be defined from the perspective of evolutionary psychologists.[48] Evolutionary psychologists view emotion as an important self-regulatory aspect of embodied cognition, and emotion as a motivator towards goal-relevant action.[48] Emotion helps drive adaptive behavior. The evolutionary perspective cites language, both spoken and written, as types of embodied cognition.[48] Pacing and non-verbal communication reflect embodied cognition in spoken language. Technical aspects of written language, such as italics, all caps, and emoticons promote an inner voice and thereby a sense of feeling rather than thinking about a written message.[48]

☰ TOC | ← Previous | Next →

Cognitive science and linguistics

George Lakoff and his collaborators have developed several lines of evidence that suggest that people use their understanding of familiar physical objects, actions and situations (such as containers, spaces, trajectories) to understand other more complex domains (such as mathematics, relationships or death). Lakoff argues that *all* cognition is based on knowledge that comes from the body and that other domains are mapped onto our embodied knowledge using a combination of conceptual metaphor, image schema and prototypes.

TOC | ← Previous | Next →

Conceptual metaphor

Main article: Conceptual metaphor

Lakoff and Mark Johnson[49] showed that humans use metaphor ubiquitously and that metaphors operate at a conceptual level (i.e., they map one conceptual domain onto another), they involve an unlimited number of individual expressions and that the same metaphor is used conventionally throughout a culture. Lakoff and his collaborators have collected thousands of examples of conceptual metaphors in many domains.[49][50]

For example, people will typically use language about journeys to discuss the history and status of a love affair, a metaphor Lakoff and Johnson call "LOVE IS A JOURNEY". It is used in such expression as: "we arrived at a crossroads," "we parted ways", "we hit the rocks" (as in a sea journey), "she's in the driver's seat", or, simply, "we're together". In cases like these, something complex (a love affair) is described in terms of something that can be done with a body (travel through space).

TOC | ← Previous | Next →

Image schema

Main article: Image schema

TOC | ← Previous | Next →

Prototypes

Main article: Prototype theory

Prototypes are "typical" members of a category, e.g. a robin is a prototypical bird, but a penguin is not. The role of prototypes in human cognition was first identified and studied by Eleanor Rosch in the 1970s.[51] She was able to show that prototypical objects are more easily categorized than non-prototypical objects, and that people answered questions about a category as a whole by reasoning about a prototype. She also identified basic level categories:[52] categories that have prototypes that

are easily visualized (such as a chair) and are associated with basic physical motions (such as "sitting"). Prototypes of basic level categories are used to reason about more general categories.

Prototype theory has been used to explain human performance on many different cognitive tasks and in a large variety of domains. George Lakoff argues that prototype theory shows that the categories that people use are based on our experience of having a body and have no resemblance to logical classes or types. For Lakoff, this shows that traditional objectivist accounts of truth cannot be correct.[53]

A classic argument against embodiment in its strict form is based on abstract meaning. Whereas the meanings of the words ‘eye’ and ‘grasp’ can be explained, to a degree, by pointing to objects and actions, those of ‘beauty’ and ‘freedom’ cannot.[54] It may be that some common sensorimotor knowledge is immanent in *freeing* actions or instantiations of *beauty*, but it seems likely that additional semantic binding principles are behind such concepts. So might it be necessary, after all, to place abstract semantics in an amodal meaning system? A remarkable observation has recently been offered that may be of the essence in this context: abstract terms show an over-proportionally strong tendency to be semantically linked to knowledge about emotions.[55][56] This additional embodied–semantic link accounts for advantages in processing speed for abstract emotional terms over otherwise matched control words.[56] In addition, abstract words strongly activate anterior cingulate cortex, a site known to be relevant for emotion processing[57] Thus, it appears that at least some abstract words are semantically grounded in emotion knowledge.

If abstract emotion words indeed receive their meaning through grounding in emotion it is of crucial relevance[58][59] Therefore, the link between an abstract emotion word and its abstract concept is via manifestation of the latter in prototypical actions. The child learns an abstract emotion word such as 'joy' because it shows JOY-expressing action schemas, which language-teaching adults use as criteria for correct application of the abstract emotion word[57][58][59] Thus, the manifestation of emotions in actions becomes the crucial link between word use and internal state, and hence between sign and meaning. Only after a stock of abstract emotion words has been grounded in emotion-expressing action can further emotion terms be learnt from context.

Artificial intelligence and robotics

History of artificial intelligence

The experience of AI research provides another line of evidence supporting the embodied mind thesis. In the early history of AI successes in programming high-level reasoning tasks such as chess-playing led to an unfounded optimism that all AI problems would be relatively quickly solved. These programs simulated intelligence using logic and high-level abstract symbols (an approach called Good old-fashioned AI). This "disembodied" approach ran into serious difficulties in the 1970s and 80s, as researchers discovered that abstract, disembodied reasoning was highly inefficient and could not achieve human-levels of competence on many simple tasks.[60] Funding agencies (such as DARPA) withdrew funding because the field of AI had failed to achieve its stated objectives, leading to difficult period now known as the "AI winter". Many AI researchers began to doubt that high level symbolic reasoning could ever perform well enough to solve simple problems.

Rodney Brooks argued in the mid-80s that these symbolic approaches were failing because researchers did not appreciate the importance of sensorimotor skills to intelligence in general, and applied these principals to robotics (an approach he called "Nouvelle AI"). Another successful new direction was neural networks—programs based on the actual structures within human bodies that gave rise to intelligence and learning. In the 90s, statistical AI achieved high levels of success in industry without using any symbolic reasoning, but instead using probabilistic techniques to make "guesses" and improve them incrementally. This process is similar to the way human beings are able to make fast, intuitive choices without stopping to reason symbolically.

☰ TOC | ← Previous | Next →

Moravec's paradox

Main article: Moravec's paradox

Moravec's paradox is the discovery by artificial intelligence and robotics researchers that, contrary to traditional assumptions, high-level reasoning requires very little computation, but low-level sensorimotor skills require enormous computational resources. The principle was articulated by Hans Moravec (whence the name) and others in the 1980s.

As Moravec writes:

☰ TOC | ← Previous | Next →

Approach to artificial intelligence

Solving problems of perception and locomotion directly

See also: Nouvelle AI, Situated, Behavior based AI, and Embodied cognitive science

Many artificial intelligence researchers have argued that a machine may need a human-like body to think and speak as well as a human being. As early as 1950, Alan Turing wrote:

Embodiment theory was brought into artificial intelligence most notably by Rodney Brooks who showed in the 1980s that robots could be more effective if they 'thought' (planned or processed) and perceived as little as possible. The robot's intelligence is geared towards only handling the minimal amount of information necessary to make its behavior be appropriate and/or as desired by its creator.

Others have argued that without taking into account both the architecture of the human brain, and embodiment, it is unrealistic to replicate accurately the processes which take place during language acquisition, comprehension, production, or during non-linguistic actions.[63] There have thus been suggestions that while robots are far from isomorphic with humans, they could benefit from strengthened associative connections in the optimization of their processes and their reactivity and sensitivity to environmental stimuli, and in situated human-machine interaction, and that the concept of multisensory integration be extended to cover linguistic input and the complementary information combined from temporally coincident sensory impressions.[63]

The embodied approach to AI has been given several names by different schools of researchers, including: Nouvelle AI (Brooks' term), Situated AI, Behavior based AI and Embodied cognitive science.

Neuroscience

One source of inspiration for embodiment theory has been research in cognitive neuroscience, such as the proposals of Gerald Edelman concerning how mathematical and computational models such as neuronal group selection and neural degeneracy result in emergent categorization.

Rohrer (2005) discusses how both our neural and developmental embodiment shape both our mental and linguistic categorizations. The degree of thought abstraction has been found to be associated with physical distance which then affects associated ideas and perception of risk.[64]

The embodied mind thesis is compatible with some views of cognition promoted in neuropsychology, such as the theories of consciousness of Vilayanur S. Ramachandran, Gerald Edelman, and Antonio Damasio.

The modeling work of cognitive neuroscientists such as Francisco Varela and Walter Freeman seeks to explain embodied and situated cognition in terms of dynamical systems theory and neurophenomenology, but rejects the idea that the brain uses representations to do so (a position also espoused by Gerhard Werner).

TOC | Previous | Next

Criticisms

Research on embodied cognition is extremely broad, covering a wide range of concepts. Methods to study embodied cognition vary from experiment to experiment based on the operational definition used by researchers. There is much evidence for embodied cognition, although interpretation of results and their significance may be disputed. Researchers continue to search for the best way to study and interpret embodied cognition.

TOC | ← Previous | Next →

Infants as examples

Some[65] criticize the notion that pre-verbal children provide an ideal channel for studying embodied cognition, especially embodied social cognition.[66] It may be impossible to know when a pre-verbal infant is a "pure model" of embodied cognition, since infants experience dramatic changes in social behavior throughout development.[65] A 9-month old has reached a different developmental stage than a 2-month old. Looking-time and reaching measures of embodied cognition may not represent embodied cognition since infants develop object permanence of objects they can see before they develop object permanence with objects they can touch.[65] True embodied cognition suggests that children would have to first physically engage with an object to understand object permanence.[65]

The response to this critique is that infants are "ideal models" of embodied cognition.[66] Infants are the best models because they utilize symbols less than adults do.[66] Looking-time could likely be a better measure of embodied cognition than reaching because infants have not developed certain fine motor skills yet.[66] Infants may first develop a passive mode of embodied cognition before they develop the active mode involving fine motor movements.[66]

TOC | ← Previous | Next →

Overinterpretation?

Some criticize the conclusions made by researchers about embodied cognition.[67] The pencil-in-teeth study is frequently cited as an example of these invalidly drawn conclusions. The researchers believed that the quicker responses to positive sentences by participants engaging their smiling muscles represented embodied cognition.[17] However, opponents argue that the effects of this exercise were primed or facilitated by the engagement of certain facial muscles.[67] Many cases of facilitative movements of the body may be incorrectly labeled as evidence of embodied cognition.[67]

TOC | ← Previous | Next →

Six views of embodied cognition

The following "Six Views of Embodied Cognition" are taken from Margaret Wilson:[68][69]

1. **"Cognition is situated**. Cognitive activity takes place in the context of a real-world environment, and inherently involves perception and action." One example of this is moving around a room while, at the same time, trying to decide where the furniture should go.
2. **"Cognition is time-pressured**. We are 'mind on the hoof' (Clark, 1997), and cognition must be understood in terms of how it functions under the pressure of real-time interaction with the environment." When you're under pressure to make a decision, the choice that is made emerges from the confluence of pressures that you're under. In the absence of pressure, a decision may be made differently.
3. **"We off-load cognitive work onto the environment**. Because of limits on our information-processing abilities (e.g., limits on attention and working memory), we exploit the environment to reduce the cognitive workload. We make the environment hold or even manipulate information for us, and we harvest that information only on a need-to-know basis." This is seen when people have calendars, agendas, PDAs, or anything to help them with everyday functions. We write things down so we can use the information when we need it, instead of taking the time to memorize or encode it into our minds.
4. **"The environment is part of the cognitive system**. The information flow between mind and world is so dense and continuous that, for scientists studying the nature of cognitive activity, the mind alone is not a meaningful unit of analysis." This statement means that the production of cognitive activity does not come from the mind alone, but rather is a mixture of the mind and the environmental situation that we are in. These interactions become part of our cognitive systems. Our thinking, decision-making, and future are all impacted by our environmental situations.
5. **"Cognition is for action**. The function of the mind is to guide action and things such as perception and memory must be understood in terms of their contribution to situation-appropriate behavior." This claim has to do with the purpose of perception and cognition. For example, visual information is processed to extract identity, location, and affordances (ways that we might interact with objects). A prominent anatomical distinction is drawn between the "what" (ventral) and "where" (dorsal) pathways in visual processing. However, the commonly labeled "where" pathway is also the "how" pathway, at least partially dedicated to action.
6. **"Off-line cognition is body-based**. Even when decoupled from the environment, the activity of the mind is grounded in mechanisms that evolved for interaction with the environment – that is, mechanisms of sensory processing and motor control." This is shown with infants or

toddlers best. Children utilize skills and abilities they were born with, such as sucking, grasping, and listening, to learn more about the environment. The skills are broken down into five main categories that combine sensory with motor skills, sensorimotor functions. The five main skills are:

1. Mental Imagery: Is visualizing something that is not currently present in your environment. For example, imagining a future activity, or recalling how many windows are on the first floor of a house you once lived in (even though you did not count them explicitly while living there).
2. Working Memory: Short term memory
3. Episodic Memory: Long term memory of specific events.
4. Implicit Memory: means by which we learn certain skills until they become automatic for us. An example of this would be an adult brushing his/her teeth, or an expert race car driver putting the car in drive.
5. Reasoning and Problem-Solving: Having a mental model of something will increase problem-solving approaches.

Criticism of the six claims

Margaret Wilson adds: "Some authors go so far as to complain that the phrase 'situated cognition' implies, falsely, that there also exists cognition that is not situated (Greeno & Moore, 1993, p. 50)."[70] Of her six claims, she notes in her abstract, "the first three and the fifth claim appear to be at least partially true, and their usefulness is best evaluated in terms of the range of their applicability. The fourth claim, I argue, is deeply problematic. The sixth claim has received the least attention, but it may in fact be the best documented and most powerful of the six claims."[71]

See also

- Action-specific perception
- Active inference
- Blue Brain Project
- Cognitive biology
- Cognitive linguistics
- Cognitive neuropsychology
- Cognitive neuroscience
- Cognitive science
- Conceptual blending
- Conceptual metaphor
- Ecological psychology
- Embodied bilingual language
- Embodied cognitive science
- Embodied embedded cognition
- Embodied music cognition
- Enactivism
- Extended cognition
- Extended mind thesis
- Externalism
- Image schema
- Moravec's paradox
- Neuroconstructivism
- Neuropsychology
- Neurophenomenology
- Philosophy of mind
- Plant cognition
- Situated cognition
- *Where Mathematics Comes From*

References

1. ^ [a] [b] [c] [d] Wilson, Robert A.; Foglia, Lucia (July 25, 2011). Edward N. Zalta, ed. "Embodied Cognition". *The Stanford Encyclopedia of Philosophy (Fall 2011 Edition)*.
2. ^ Varela, Thompson & Rosch 1992
3. ^ Eleanor Rosch; Evan Thompson; Francisco J. Varela (1991). *The embodied mind: Cognitive science and human experience* (Paperback 1992 ed.). MIT Press. ISBN 978-0262720212.
4. ^ For example, Lawrence Shapiro, ed. (2014). *The Routledge Handbook of Embodied Cognition*. Routledge. ISBN 9781317688662. includes articles on extended cognition and situated cognition.
5. ^ Michael Dawson (2014). "Chapter 6: Embedded and situated cognition". In Lawrence Shapiro. *The Routledge Handbook of Embodied Cognition*. Routledge. pp. 59–67. ISBN 9781317688655.
6. ^ Marcin Milkowski (2013). *Explaining the Computational Mind*. MIT Press. p. 4. ISBN 9780262018869.
7. ^ David Chalmers (ed.). "The Extended Mind". *Philosophy of the mind*. philpapers: philosophical research on line. Retrieved February 2015. See also: Andy Clark; David J Chalmers (2010). "Chapter 2: The extended mind". In Richard Menary. *The extended mind*. MIT Press. pp. 27 *ff*. ISBN 9780262014038.
8. ^ Andy Clark (2008). *Supersizing the Mind : Embodiment, Action, and Cognitive Extension: Embodiment, Action, and Cognitive Extension*. Cambridge University Press. p. 107. ISBN 9780199715534. "no genuinely cognitive system will turn out to consist *entirely* of the kind of external resources that fans of extended cognition typically invoke"
9. ^ Immanuel Kant, *Universal Natural History and Theory of the Heavens*, p.367; translated by Stephen Palmquist in Kant's Critical Religion (Aldershot: Ashgate, 2000), p.320.
10. ^ Andrew Carpenter (2008). "Kant on the embodied cognition". فلسفه. **36** (1): 59–68.
11. ^ Eleanor Rosch; Evan Thompson; Francisco J. Varela (1992). "Chapter 4: The *I* of the storm". *The Embodied Mind: Cognitive Science and Human Experience*. MIT Press. p. 70. ISBN 9780262261234.
12. ^ Helge Svare (2006). "Chapter 7: The body and the transcendental". *Body and Practice in Kant*. Springer Science & Business Media. pp. 213 *ff*. ISBN 9781402041198.
13. ^ Cowart, Monica 2004 Embodied Cognition The Internet Encyclopedia of Philosophy, ISSN 2161-0002, [1], retrieved 27 Feb 2012.
14. ^ Horst Hendriks-Jansen (1996). *Catching Ourselves in the Act: Situated Activity, Interactive Emergence, Evolution, and Human Thought*. MIT Press. ISBN 9780262082464.

15. ^ Di Paolo, Ezequiel Shallow and Deep Embodiment University of Sussex, 29.10.2009 12:43 Duration: 1:11:38 https://cast.switch.ch/vod/clips/74nrkbwys (Video, retrieved 27 Feb 2012 [2]
16. ^ *a b c d e f* Borghi, Anna M.; Cimatti, Felice (2010). "Embodied cognition and beyond: Acting and sensing the body". *Neuropsychologia*. **48** (3): 763–773. doi:10.1016/j.neuropsychologia.2009.10.029. ISSN 0028-3932. PMID 19913041.
17. ^ *a b* Diane Pecher; Rolf A. Zwaan (10 January 2005). *Grounding Cognition: The Role of Perception and Action in Memory, Language, and Thinking*. Cambridge University Press. pp. 115–. ISBN 978-1-139-44247-3.
18. ^ Lakoff & Johnson (1980); Lakoff (1987); Lakoff & Turner (1989); Lakoff & Johnson (1999); Lakoff & Nunez 2000
19. ^ Moravec 1988, Brooks 1990, Pfeiffer 2001
20. ^ Clark 1997, Hendriks-Jansen 1996
21. ^ Edelman 2004, Damasio 1999
22. ^ Maturana & Varela 1987, Varela, Thompson & Rosch 1992
23. ^ Liberman, AM; Cooper, FS; Shankweiler, DP; Studdert-Kennedy, M (1967). "Perception of the speech code". *Psychological Review*. **74** (6): 431–61. doi:10.1037/h0020279. PMID 4170865.
24. ^ Liberman, AM; Mattingly, IG (1985). "The motor theory of speech perception revised". *Cognition*. **21** (1): 1–36. doi:10.1016/0010-0277(85)90021-6. PMID 4075760.
25. ^ Liberman, AM; Mattingly, IG (1989). "A specialization for speech perception". *Science*. **243** (4890): 489–94. doi:10.1126/science.2643163. PMID 2643163.
26. ^ Liberman, AM; Whalen, DH (2000). "On the relation of speech to language". *Trends in Cognitive Sciences*. **4** (5): 187–196. doi:10.1016/S1364-6613(00)01471-6. PMID 10782105.
27. ^ Galantucci, B; Fowler, CA; Turvey, MT (2006). "The motor theory of speech perception reviewed". *Psychonomic Bulletin & Review*. **13** (3): 361–77. doi:10.3758/bf03193857. PMC 2746041 . PMID 17048719.
28. ^ *a b c d e f g h* Bekkering H, Neggers SF (2002). "Visual search is modulated by action intentions". *Psychol Sci*. **13** (4): 370–4. doi:10.1111/j.0956-7976.2002.00466.x. PMID 12137141.
29. ^ *a b c d e f g h i* Balcetis E, Dunning D (2007). "Cognitive dissonance and the perception of natural environments". *Psychol Sci*. **18** (10): 917–21. doi:10.1111/j.1467-9280.2007.02000.x. PMID 17894610.
30. ^ *a b c d e f g* Tversky, Barbara; Hard, Bridgette Martin (2009). "Embodied and disembodied cognition: Spatial perspective-taking". *Cognition*. **110** (1): 124–129.

doi:10.1016/j.cognition.2008.10.008. ISSN 0010-0277. PMID 19056081.

31. ^ Paradowski MB (2014). "Storytelling in language teaching – re-evaluating the weight of kinaesthetic modality for brain-compatible pedagogy". *Storytelling: An Interdisciplinary Journal*. **1** (2): 13–52.
32. ^ *a b c d e f g* Olmstead AJ, Viswanathan N, Aicher KA, Fowler CA (2009). "Sentence comprehension affects the dynamics of bimanual coordination: implications for embodied cognition". *Q J Exp Psychol (Hove)*. **62** (12): 2409–17. doi:10.1080/17470210902846765. PMID 19396732.
33. ^ Trofimova, IN (1999). "How people of different age sex and temperament estimate the world". *Psychological Reports*. **85/2**: 533–552. doi:10.2466/pr0.1999.85.2.533.
34. ^ Trofimova, IN (2012). "Understanding misunderstanding: a study of sex differences in meaning attribution". *Psychological Research*. **77** (6): 748–760. doi:10.1007/s00426-012-0462-8.
35. ^ Trofimova, IN (2014). "Observer bias: an interaction of temperament traits with biases in the semantic perception of lexical material". *PLoS ONE*. **9** (1): e85677. doi:10.1371/journal.pone.0085677. PMC 3903487 . PMID 24475048.
36. ^ *a b c d e f g h* Scott, Christina L.; Harris, Richard Jackson; Rothe, Alicia R. (2001). "Embodied Cognition Through Improvisation Improves Memory for a Dramatic Monologue". *Discourse Processes*. **31** (3): 293–305. doi:10.1207/S15326950dp31-3_4. ISSN 0163-853X.
37. ^ Hyun, J. S.; Luck, S. J. (2007). "Visual working memory as the substrate for mental rotation". *Psychonomic Bulletin & Review*. **14** (1): 154–158. doi:10.3758/bf03194043.
38. ^ Moreau, D (2012). "The role of motor processes in three-dimensional mental rotation: Shaping cognitive processing via sensorimotor experience". *Learning and Individual Differences*. **22** (3): 354–359. doi:10.1016/j.lindif.2012.02.003.
39. ^ Moreau, D (2013a). "Constraining movement alters the recruitment of motor processes in mental rotation". *Experimental Brain Research*. **224** (3): 447–454. doi:10.1007/s00221-012-3324-0.
40. ^ Moreau, D.; Clerc, J.; Mansy-Dannay, A.; Guerrien, A. (2012). "Enhancing spatial ability through sport practice: Evidence for an effect of motor training on mental rotation performance". *Journal of Individual Differences*. **33** (2): 83–88. doi:10.1027/1614-0001/a000075.
41. ^ Moreau, D (2013b). "Motor expertise modulates movement processing in working memory". *Acta Psychologica*. **142** (3): 356–361. doi:10.1016/j.actpsy.2013.01.011.
42. ^ *a b c d e f g h* Dantzig, Saskia van; Zeelenberg, René; Pecher, Diane (2009). "Unconstraining theories of embodied cognition". *Journal of Experimental Social Psychology*. **45** (2): 345–351.

doi:10.1016/j.jesp.2008.11.001. ISSN 0022-1031.

43. ^ *a b c d e* Labroo, Aparna A.; Nielsen, Jesper H. (2010). "Half the Thrill Is in the Chase: Twisted Inferences from Embodied Cognitions and Brand Evaluation". *Journal of Consumer Research*. **37** (1): 143–158. doi:10.1086/649908. ISSN 0093-5301.
44. ^ *a b c d* Hung, Iris W.; Labroo, Aparna A. (2011). "From Firm Muscles to Firm Willpower: Understanding the Role of Embodied Cognition in Self-Regulation". *Journal of Consumer Research*. **37** (6): 1046–1064. doi:10.1086/657240. ISSN 0093-5301.
45. ^ Shalev, I. (2014). "Implicit Energy Loss: Embodied Dryness Cues Influence Vitality and Depletion". *Journal of Consumer Psychology*. **24**: 260–270. doi:10.1016/j.jcps.2013.09.011.
46. ^ *a b* Balcetis, Emily; Cole, Shana (2009). "Body in Mind: The Role of Embodied Cognition in Self-Regulation". *Social and Personality Psychology Compass*. **3** (5): 759–774. doi:10.1111/j.1751-9004.2009.00197.x. ISSN 1751-9004.
47. ^ *a b c d e* Vacharkulksemsuk T, Fredrickson BL (2012). "Strangers in sync: Achieving embodied rapport through shared movements". *J Exp Soc Psychol*. **48** (1): 399–402. doi:10.1016/j.jesp.2011.07.015. PMC 3290409 . PMID 22389521.
48. ^ *a b c d* Kaschak, Michael P.; Maner, Jon K.; Miller, Saul; Coyle, Jacqueline M. (2009). "Embodied social cognition: Bodies, emotions, and blackberries". *European Journal of Social Psychology*. **39** (7): 1255–1256. doi:10.1002/ejsp.692. ISSN 0046-2772.
49. ^ *a b* Lakoff & Johnson 1980.
50. ^ Lakoff & Turner 1989.
51. ^ Rosch, Eleanor (1973). "Natural categories". *Cognitive Psychology*. **4** (3): 328–350. doi:10.1016/0010-0285(73)90017-0.
52. ^ Rosch, Eleanor (1978). "Principles of Categorization". In Rosch, Eleanor; Lloyd, B. B. *Cognition and Categorization'*. Lawrence Erlbaum Associates. pp. 7–48.
53. ^ *Lakoff, G. Women, Fire, and Dangerous Things: What Categories Reveal About the Mind.* University of Chicago Press. ISBN 0-226-46804-6.
54. ^ Pulvermuller, Friedemann (2013). "How neurons make meaning: brain mechanisms for embodied and abstract-symbolic semantics" (PDF). *Trends in Cognitive Sciences*. Elsevier. **17** (9): 458–470. doi:10.1016/j.tics.2013.06.004. PMID 23932069.
55. ^ Meteyard, L.; et al. (2012). "Coming of age: a review of embodiment and the neuroscience of semantics". *Cortex*. **48**: 788–804. doi:10.1016/j.cortex.2010.11.002. PMID 21163473.
56. ^ *a b* Kousta, S.T.; et al. (2011). "The representation of abstract words: why emotion matters". *J. Exp. Psychol. Gen*. **140**: 14–34.
57. ^ *a b* Vigliocco, G.; et al. (2013). "The neural representation of abstract words: the role of emotion". *Cereb. Cortex*. **24**: 1767–1777. doi:10.1093/cercor/bht025.

58. ^ *a* *b* Wittgenstein, L. (1953). *Philosophical Investigations*. Blackwell Publishers.
59. ^ *a* *b* Baker, G.P.; Hacker, P.M.S. (2009). *Wittgenstein: Understanding and Meaning, Part 1: Essays. Wiley-Blackwell*.
60. ^ See History of AI § The problems
61. ^ Moravec 1988, pp. 15–16.
62. ^ Turing 1950.
63. ^ *a* *b* Paradowski, Michał B. 2012. Developing embodied multisensory dialogue agents. In: Rzepka, Rafał, Michał Ptaszyński & Paweł Dybala (Eds.) Linguistic and Cognitive Approaches to Dialogue Agents. Birmingham: The Society for the Study of Artificial Intelligence and Simulation of Behaviour, 6–14.
64. ^ Liberman N, Trope Y (2008-11-21). "The Psychology of Transcending the Here and Now". *Science*. **322** (5905): 1201–1205. doi:10.1126/science.1161958. PMC 2643344 . PMID 19023074.
65. ^ *a* *b* *c* *d* Longo, M. R. (2009). "What's embodied and how can we tell?". *European Journal of Social Psychology*. **39** (7): 1207–1209. doi:10.1002/ejsp.684.
66. ^ *a* *b* *c* *d* *e* Daum, Moritz M.; Sommerville, Jessica A.; Prinz, Wolfgang (2009). "Disentangling embodied and symbolic modes of social understanding". *European Journal of Social Psychology*. **39** (7): 1214–1216. doi:10.1002/ejsp.686. ISSN 0046-2772.
67. ^ *a* *b* *c* Adams, F. (2010). "Embodied cognition". *Phenomenology and the Cognitive Sciences*. **9** (4): 619–628. doi:10.1007/s11097-010-9175-x.
68. ^ "Margaret Wilson -". *people.ucsc.edu*. Retrieved 23 March 2018.
69. ^ Wilson, Margaret (2002). "Six Views of Embodied Cognition" (PDF). *Psychonomic Bulletin & Review*. **9** (4): 625–636. doi:10.3758/BF03196322
70. ^ Wilson (2002: 627).
71. ^ Wilson (2002: 625).

- Brooks, Rodney A. (1999). *Cambrian Intelligence: The Early History of the New AI*. Cambridge MA: The MIT Press. ISBN 0-262-52263-2
- Clark, Andy (1997). *Being There: Putting Brain, Body and World Together Again*. Cambridge MA: The MIT Press. ISBN 0-262-53156-9
- Damasio, Antonio (1999). *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*. New York: Houghton Mifflin Harcourt. ISBN 0-15-601075-5
- Edelman, G (2004). *Wider than the Sky: The Phenomenal Gift of Consciousness*. Yale University Press. ISBN 0-300-10229-1
- Gallagher, S. (2005). *How the Body Shapes the Mind*. Oxford: Oxford University Press. ISBN

0-19-920416-0.

- Hendriks-Jansen, Horst (1996) *Catching Ourselves in the Act: Situated Activity, Interactive Emergence, Evolution, and Human Thought*. Cambridge MA: The MIT Press. ISBN 0-262-08246-2
- Hyun, J. S.; Luck, S. J. (2007). "Visual working memory as the substrate for mental rotation". *Psychonomic Bulletin & Review*. **14** (1): 154–158. doi: 10.3758/bf03194043.
- Lakoff, George and Johnson, Mark (1980) *Metaphors We Live By*. University of Chicago Press. ISBN 0-226-46801-1
- Lakoff, George (1987) *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind* University of Chicago Press. ISBN 0-226-46804-6.
- Lakoff, George and Turner, Mark (1989) *More Than Cool Reason: A Field Guide to Poetic Metaphor*. University of Chicago Press. ISBN 0-226-46812-7
- Lakoff, George and Johnson, Mark (1999) *Philosophy In The Flesh: the Embodied Mind and its Challenge to Western Thought*. Basic Books. ISBN 0-465-05674-1
- Lakoff, George and Nuñez, Rafael. (2001). *Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being*. New York: Basic Books. ISBN 0-465-03771-2
- Maturana, Humberto and Varela, Francisco (1987) *The Tree of Knowledge: The Biological Roots of Human Understanding.* Boston: Shambhala. ISBN 0-87773-373-2
- Pfeifer, R. (2001) *Understanding Intelligence*. Cambridge MA: The MIT Press. ISBN 0-262-16181-8
- Pfeifer, R. and Bongard, J. (2006) *How the Body Shapes the Way We Think: A New View of Intelligence*. Cambridge MA: The MIT Press. ISBN 978-0-262-16239-5
- Varela, Francisco J., Thompson, Evan T., and Rosch, Eleanor. (1991). *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, Massachusetts: The MIT Press. ISBN 0-262-72021-3
- Greeno, J.G; Moore, J.L. (1993). "Situativity and symbols: Response to Vera and Simon". *Cognitive Science*. **17**: 49–59. doi: 10.1207/s15516709cog1701_3.
- Wilson, M. (2001). The case for sensorimotor coding in working memory. Psychonomic Bulletin and Review, *, 44–57.

External links

- The Situated Body, a special issue of *Janus Head: Journal of Interdisciplinary Studies in Literature, Continental Philosophy, Phenomenological Psychology and the Arts*. Guest edited by Shaun Gallagher.
- Embodiment and Experientialism from the *Handbook of Cognitive Linguistics* (pdf)
- Embodied Cognition: A Field Guide (pdf) – from an Artificial Intelligence perspective
- Where the Action Is by Paul Dourish- for applications to human-computer interaction.
- Pragmatism, Ideology, and Embodiment: William James and the Philosophical Foundations of Embodiment by Tim Rohrer
- Society for the Scientific Study of Embodiment
- Embodied Cognition – Internet Encyclopedia of Philosophy
- 2001 Summary of how the embodiment hypothesis of cognitive linguistics has begun to interact with theories of embodiment in fields ranging from cognitive anthropology to cognitive neuroscience
- Goddard College's Embodiment Studies Web Resources
- Embodiment Resources – for those researching into embodiment, particularly as it relates to phenomenology, sociology and cognitive neuroscience.
- EUCog – European Network for the Advancement of Artificial Cognitive Systems, Interaction and Robotics Many references here to up to date research on embodiment and enaction

Categories: Cognitive science | Enactive cognition | Philosophy of artificial intelligence | Mind–body problem

This page was last edited on 14 May 2018, at 15:46.

Back to main TOC

Contents

Executive Dysfunction

Jump to navigation Jump to search
For the condition characterized by comorbidity of a specific set of impairments to executive functioning, see Dysexecutive syndrome.

In psychology and neuroscience, **executive dysfunction**, or **executive function deficit**, is a disruption to the efficacy of the executive functions, which is a group of cognitive processes that regulate, control, and manage other cognitive processes.[1] Executive dysfunction can refer to both neurocognitive deficits and behavioural symptoms. It is implicated in numerous psychopathologies and mental disorders, as well as short-term and long-term changes in non-clinical executive control.

Executive dysfunction is not the same as dysexecutive syndrome, a term coined by Alan Baddeley to describe a common pattern of dysfunction in executive functions, such as deficiencies in planning, abstract thinking, flexibility and behavioural control.[2][3] This group of symptoms, usually resulting from brain damage, tend to occur together.[4] However, the existence of dysexecutive syndrome is controversial.[5]

TOP

TOC Next

Overview

Executive functioning is a theoretical construct representing a domain of cognitive processes that regulate, control, and manage other cognitive processes. Executive functioning is not a unitary concept; it is a broad description of the set of processes involved in certain areas of cognitive and behavioural control.[1] Executive processes are integral to higher brain function, particularly in the areas of goal formation, planning, goal-directed action, self-monitoring, attention, response inhibition, and coordination of complex cognition and motor control for effective performance.[6] Deficits of the executive functions are observed in all populations to varying degrees, but severe executive dysfunction can have devastating effects on cognition and behaviour in both individual and social contexts.

Executive dysfunction does occur to a minor degree in all individuals on both short-term and long-term scales. In non-clinical populations, the activation of executive processes appears to inhibit further activation of the same processes, suggesting a mechanism for normal fluctuations in executive control.[7] Decline in executive functioning is also associated with both normal and clinical aging.[8] In aging populations, the decline of memory processes appears to affect executive functions, which also points to the general role of memory in executive functioning.[9]

Executive dysfunction appears to consistently involve disruptions in task-oriented behavior, which requires executive control in the inhibition of habitual responses and goal activation.[10] Such executive control is responsible for adjusting behaviour to reconcile environmental changes with goals for effective behaviour.[11] Impairments in set shifting ability are a notable feature of executive dysfunction; set shifting is the cognitive ability to dynamically change focus between points of fixation based on changing goals and environmental stimuli.[12] This offers a parsimonious explanation for the common occurrence of impulsive, hyperactive, disorganized, and aggressive behaviour in clinical patients with executive dysfunction. Executive dysfunction, particularly in working

memory capacity, may also lead to varying degrees of emotional dysregulation, which can manifest as chronic depression, anxiety, or hyperemotionality.[13] Russell Barkley proposed a hybrid model of the role of behavioural disinhibition in the presentation of ADHD, which has served as the basis for much research of both ADHD and broader implications of the executive system.[14]

Other common and distinctive symptoms of executive dysfunction include utilization behaviour, which is compulsive manipulation/use of nearby objects due simply to their presence and accessibility (rather than a functional reason); and imitation behaviour, a tendency to rely on imitation as a primary means of social interaction.[15] Research also suggests that executive set shifting is a co-mediator with episodic memory of feeling-of-knowing (FOK) accuracy, such that executive dysfunction may reduce FOK accuracy.[16]

There is some evidence suggesting that executive dysfunction may produce beneficial effects as well as maladaptive ones. Abraham et al.[17] demonstrate that creative thinking in schizophrenia is mediated by executive dysfunction, and they establish a firm etiology for creativity in psychoticism, pinpointing a cognitive preference for broader top-down associative thinking versus goal-oriented thinking, which closely resembles aspects of ADHD. It is postulated that elements of psychosis are present in both ADHD and schizophrenia/ schizotypy due to dopamine overlap.[18]

Cause

The cause of executive dysfunction is heterogeneous,[19] as many neurocognitive processes are involved in the executive system and each may be compromised by a range of genetic and environmental factors. Learning and development of long-term memory play a role in the severity of executive dysfunction through dynamic interaction with neurological characteristics. Studies in cognitive neuroscience suggest that executive functions are widely distributed throughout the brain, though a few areas have been isolated as primary contributors. Executive dysfunction is studied extensively in clinical neuropsychology as well, allowing correlations to be drawn between such dysexecutive symptoms and their neurological correlates.

Executive processes are closely integrated with memory retrieval capabilities for overall cognitive control; in particular, goal/task-information is stored in both short-term and long-term memory, and effective performance requires effective storage and retrieval of this information.[11]

Executive dysfunction characterizes many of the symptoms observed in numerous clinical populations. In the case of acquired brain injury and neurodegenerative diseases there is a clear neurological etiology producing dysexecutive symptoms. Conversely, syndromes and disorders are defined and diagnosed based on their symptomatology rather than etiology. Thus, while Parkinson's disease, a neurodegenerative condition, causes executive dysfunction, a disorder such as attention-deficit/hyperactivity disorder is a classification given to a set of subjectively-determined symptoms implicating executive dysfunction – current models indicate that such clinical symptoms are caused by executive dysfunction.[14][19]

TOC Previous Next

Neurophysiology

As previously mentioned, executive functioning is not a unitary concept.[1]

Many studies have been conducted in an attempt to pinpoint the exact regions of the brain that lead to executive dysfunction, producing a vast amount of often conflicting information indicating wide and inconsistent distribution of such functions. A common assumption is that disrupted executive control processes are associated with pathology in prefrontal brain regions.[20] This is supported to some extent by the primary literature, which shows both pre-frontal activation and communication between the pre-frontal cortex and other areas associated with executive functions such as the basal ganglia and cerebellum.[19][21]

In most cases of executive dysfunction, deficits are attributed to either frontal lobe damage or dysfunction, or to disruption in fronto-subcortical connectivity.[1] Neuroimaging with PET and fMRI has confirmed the relationship between executive function and functional frontal pathology.[1] Neuroimaging studies have also suggested that some constituent functions are not discretely localized in prefrontal regions.[22] Functional imaging studies using different tests of executive function have implicated the dorsolateral prefrontal cortex to be the primary site of cortical activation during these tasks.[23] In addition, PET studies of patients with Parkinson's disease have suggested that tests of executive function are associated with abnormal function in the globus pallidus[1] and appear to be the genuine result of basal ganglia damage.[1]

With substantial cognitive load, fMRI signals indicate a common network of frontal, parietal and occipital cortices, thalamus, and the cerebellum.[24] This observation suggests that executive function is mediated by dynamic and flexible networks that are characterized using functional integration and effective connectivity analyses.[1] The complete circuit underlying executive function includes both a direct and an indirect circuit.[23] The neural circuit responsible for executive functioning is, in fact, located primarily in the frontal lobe.[23] This main circuit originates in the dorsolateral prefrontal cortex/orbitofrontal cortex and then projects through the striatum and thalamus to return to the prefrontal cortex.[23]

Not surprisingly, plaques and tangles in the frontal cortex can cause disruption in functions as well as damage to the connections between

prefrontal cortex and the hippocampus.[20] Another important point is in the finding that structural MRI images link the severity of white matter lesions to deficits in cognition.[25]

The emerging view suggests that cognitive processes materialize from networks that span multiple cortical sites with closely collaborative and over-lapping functions.[22] A challenge for future research will be to map the multiple brain regions that might combine with each other in a vast number of ways, depending on the task requirements.[22]

Genetics

Certain genes have been identified with a clear correlation to executive dysfunction and related psychopathologies. According to Friedman *et al.* (2008),[26] the heritability of executive functions is among the highest of any psychological trait. The dopamine receptor D4 gene (DRD4) with 7'-repeating polymorphism (7R) has been repeatedly shown to correlate strongly with impulsive response style on psychological tests of executive dysfunction, particularly in clinical ADHD.[27] The catechol-o-methyl transferase gene (COMT) codes for an enzyme that degrades catecholamine neurotransmitters (DA and NE), and its Val158Met polymorphism is linked with the modulation of task-oriented cognition and behavior (including set shifting[28]) and the experience of reward, which are major aspects of executive functioning. COMT is also linked to methylphenidate (stimulant medication) response in children with ADHD.[29] Both the DRD4/7R and COMT/Val158Met polymorphisms are also correlated with executive dysfunction in schizophrenia and schizotypal behaviour.[30]

Testing and measurement

There are several measures that can be employed to assess the executive functioning capabilities of an individual. Although a trained non-professional working outside of an institutionalized setting can legally and competently perform many of these measures, a trained professional administering the test in a standardized setting will yield the most accurate results.[31]

Clock drawing test

The Clock drawing test (CDT) is a brief cognitive task that can be used by physicians who suspect neurological dysfunction based on history and physical examination. It is relatively easy to train non-professional staff to administer a CDT. Therefore, this is a test that can easily be administered in educational and geriatric settings and can be utilized as a precursory measure to indicate the likelihood of further/future deficits.[32] Also, generational, educational and cultural differences are not perceived as impacting the utility of the CDT.[33]

The procedure of the CDT begins with the instruction to the participant to draw a clock reading a specific time (generally 11:10). After the task is complete, the test administrator draws a clock with the hands set at the same specific time. Then the patient is asked to copy the image.[34] Errors in clock drawing are classified according to the following categories: omissions, perseverations, rotations, misplacements, distortions, substitutions and additions.[32] Memory, concentration, initiation, energy, mental clarity and indecision are all measures that are scored during this activity.[35] Those with deficits in executive functioning will often make errors on the first clock but not the second.[32] In other words, they will be unable to generate their own example, but will show proficiency in the copying task.

Stroop task

The cognitive mechanism involved in the Stroop task is referred to as directed attention. The Stroop task requires the participant to engage in and allows assessment of processes such as attention management, speed and accuracy of reading words and colours and of inhibition of competing stimuli.[36] The stimulus is a colour word that is printed in a different colour than what the written word reads. For example, the word "red" is written in a blue font. One must verbally classify the colour that the word is displayed/printed in, while ignoring the information provided by the written word. In the aforementioned example, this would require the participant to say "blue" when presented with the stimulus. Although the majority of people will show some slowing when given incompatible text versus font colour, this is more severe in individuals with deficits in inhibition. The Stroop task takes advantage of the fact that most humans are so proficient at reading colour words that it is extremely difficult to ignore this information, and instead acknowledge, recognize and say the colour the word is printed in.[37] The Stroop task is an assessment of attentional vitality and flexibility.[36] More modern variations of the Stroop task tend to be more difficult and often try to limit the sensitivity of the test.[38]

Wisconsin card sorting test

The Wisconsin Card Sorting Test (WCST) is used to determine an individual's competence in abstract reasoning, and the ability to change problem-solving strategies when needed.[36] These abilities are primarily determined by the frontal lobes and basal ganglia, which are crucial components of executive functioning;[39] making the WCST a good measure for this purpose.[*citation needed*]

The WCST utilizes a deck of 128 cards that contains four stimulus cards.[36] The figures on the cards differ with respect to color, quantity, and shape. The participants are then given a pile of additional cards and are asked to match each one to one of the previous cards. Typically, children

between ages 9 and 11 are able to show the cognitive flexibility that is needed for this test.[40][41]

TOC Previous Next

Trail-making test

Another prominent test of executive dysfunction is known as the Trail-making test. This test is composed of two main parts (Part A & Part B). Part B differs from Part A specifically in that it assesses more complex factors of motor control and perception.[42] Part B of the Trail-making test consists of multiple circles containing letters (A-L) and numbers (1-12). The participant's objective for this test is to connect the circles in order, alternating between number and letter (e.g. 1-A-2-B) from start to finish.[43] The participant is required not to lift their pencil from the page. The task is also timed as a means of assessing speed of processing.[44] Set-switching tasks in Part B have low motor and perceptual selection demands, and therefore provide a clearer index of executive function.[42] Throughout this task, some of the executive function skills that are being measured include impulsivity, visual attention and motor speed.[44]

TOC Previous Next

In clinical populations

The executive system's broad range of functions relies on, and is instrumental in, a broad range of neurocognitive processes. Clinical presentation of severe executive dysfunction that is unrelated a specific disease or disorder is classified as a dysexecutive syndrome, and often appears following damage to the frontal lobes of the cerebral cortex.[45] As a result, Executive dysfunction is implicated etiologically and/or co-morbidly in many psychiatric illnesses, which often show the same symptoms as the dysexecutive syndrome. It has been assessed and researched extensively in relation to cognitive developmental disorders, psychotic disorders, affective disorders, and conduct disorders, as well as neurodegenerative diseases and acquired brain injury (ABI).

Environmental dependency syndrome is a dysexecutive syndrome marked by significant behavioural dependence on environmental cues and is marked by excessive imitation and utilization behaviour.[46] It has been observed in patients with a variety of etiologies including ABI, exposure to phendimetrazine tartrate,[47] stroke, and various frontal lobe lesions.[46]

Schizophrenia

Schizophrenia is commonly described as a mental disorder in which a person becomes detached from reality because of disruptions in the pattern of thinking and perception.[48] Although the etiology is not completely understood, it is closely related to dopaminergic activity and is strongly associated with both neurocognitive and genetic elements of executive dysfunction.[30] Individuals with schizophrenia may demonstrate amnesia for portions of their episodic memory. Observed damage to explicit, consciously accessed, memory is generally attributed to the fragmented thoughts that characterize the disorder.[48] These fragmented thoughts are suggested to produce a similarly fragmented organization in memory during encoding and storage, making retrieval more difficult.

However, implicit memory is generally preserved in patients with schizophrenia.

Patients with schizophrenia demonstrate spared performance on measures of visual and verbal attention and concentration, as well as on immediate digit span recall, suggesting that observed deficits cannot be attributed to deficits in attention or short-term memory.[49] However, impaired performance was measured on psychometric measures assumed to assess higher order executive function. Working memory and multi-tasking impairments typically characterize the disorder.[17] Persons with schizophrenia also tend to demonstrate deficits in response inhibition and cognitive flexibility.[50]

Patients often demonstrate noticeable deficits in the central executive component of working memory as conceptualized by Baddeley and Hitch. However, performance on tasks associated with the phonological loop and visuospatial sketchpad are typically less affected.[48][51] More specifically, patients with schizophrenia show impairment to the central executive component of working memory, specific to tasks in which the visuospatial system is required for central executive control.[49] The phonological system appears to be more generally spared overall.

Attention deficit hyperactivity disorder

A triad of core symptoms, namely inattention, hyperactivity, and impulsivity characterize attention deficit/hyperactivity disorder. Individuals with ADHD often experience problems with organization, discipline, and setting priorities, and these difficulties often persist from childhood through adulthood.[52] In both children and adults with ADHD, an underlying executive dysfunction involving the prefrontal regions and other interconnected subcortical structures has been found.[52] As a result, people with ADHD commonly perform more poorly than matched controls on interference control, mental flexibility and semantic verbal fluency.[14][52][53] Also, a more central impairment in self-regulation is noted in cases of ADHD.[14] However, some research has suggested the possibility that

the severity of executive dysfunction in individuals with ADHD declines with age as they learn to compensate for the aforementioned deficits.[52] Thus, a decrease in executive dysfunction in adults with ADHD as compared to children with ADHD is thought reflective of compensatory strategies employed on behalf of the adults (e.g. using schedules to organize tasks) rather than neurological differences.

Although ADHD has typically been conceptualized in a categorical diagnostic paradigm, it has also been proposed that this disorder should be considered within a more dimensional behavioural model that links executive functions to observed deficits.[53] Proponents argue that classic conceptions of ADHD falsely localize the problem at perception (input) rather than focusing on the inner processes involved in producing appropriate behaviour (output).[53] Moreover, others have theorized that the appropriate development of inhibition (something that is seen to be lacking in individuals with ADHD) is essential for the normal performance of other neuropsychological abilities such as working memory, and emotional self-regulation.[14] Thus, within this model, deficits in inhibition are conceptualized to be developmental and the result of atypically operating executive systems.

TOC | Previous | Next

Autism spectrum disorder

Autism is diagnosed based on the presence of markedly abnormal or impaired development in social interaction and communication and a markedly restricted repertoire of activities and interests. It is a disorder that is defined according to behaviour as no specific biological markers are known.[48] Due to the variability in severity and impairment in functioning exhibited by persons with autism, the disorder is typically conceptualized as existing along a continuum (or spectrum) of severity.

Individuals with autism commonly show impairment in three main areas of executive functioning:[54][55][56][57]

- **Fluency.** Fluency refers to the ability to generate novel ideas and responses. Although adult populations are largely underrepresented in

this area of research, findings have suggested that children with autism generate fewer novel words and ideas and produce less complex responses than matched controls.

- **Planning.** Planning refers to a complex, dynamic process, wherein a sequence of planned actions must be developed, monitored, re-evaluated and updated. Persons with autism demonstrate impairment on tasks requiring planning abilities relative to typically functioning controls, with this impairment maintained over time. As might be suspected, in the case of autism comorbid with learning disability, an additive deficit is observed in many cases.
- **Flexibility.** Poor mental flexibility, as demonstrated in individuals with autism, is characterized by perseverative, stereotyped behaviour, and deficits in both the regulation and modulation of motor acts. Some research has suggested that individuals with autism experience a sort of 'stuck-in-set' perseveration that is specific to the disorder, rather than a more global perseveration tendency. These deficits have been exhibited in cross-cultural samples and have been shown to persist over time.

Although there has been some debate, inhibition is generally no longer considered to be an executive function deficit in people with autism.[54][57] Individuals with autism have demonstrated differential performance on various tests of inhibition, with results being taken to indicate a general difficulty in the inhibition of a habitual response.[57] However, performance on the Stroop task, for example, has been unimpaired relative to matched controls. An alternative explanation has suggested that executive function tests that demonstrate a clear rationale are passed by individuals with autism.[57] In this light, it is the design of the measures of inhibition that have been implicated in the observation of impaired performance rather than inhibition being a core deficit.

In general, individuals with autism show relatively spared performance on tasks that do not require mentalization.[48] These include: use of desire and emotion words, sequencing behavioural pictures, and the recognition of basic facial emotional expressions. In contrast, individuals with autism typically demonstrated impaired performance on tasks that do require mentalizing.[48] These include: false beliefs, use of belief and idea words,

sequencing mentalistic pictures, and recognizing complex emotions such as admiring or scheming.

Bipolar disorder

Bipolar disorder is a mood disorder that is characterized by both highs (mania) and lows (depression) in mood. These changes in mood sometimes alternate rapidly (changes within days or weeks) and sometimes not so rapidly (within weeks or months).[56] Current research provides strong evidence of cognitive impairments in individuals with bipolar disorder, particularly in executive function and verbal learning.[58] Moreover, these cognitive deficits appear to be consistent cross-culturally,[58] indicating that these impairments are characteristic of the disorder and not attributable to differences in cultural values, norms, or practice. Functional neuroimaging studies have implicated abnormalities in the dorsolateral prefrontal cortex and the anterior cingulate cortex as being volumetrically different in individuals with bipolar disorder.[58]

Individuals affected by bipolar disorder exhibit deficits in strategic thinking, inhibitory control, working memory, attention, and initiation that are independent of affective state.[56][59] In contrast to the more generalized cognitive impairment demonstrated in persons with schizophrenia, for example, deficits in bipolar disorder are typically less severe and more restricted. It has been suggested that a "stable dys-regulation of prefrontal function or the subcortical-frontal circuitry [of the brain] may underlie the cognitive disturbances of bipolar disorder".[60] Executive dysfunction in bipolar disorder is suggested to be associated particularly with the manic state, and is largely accounted for in terms of the formal thought disorder that is a feature of mania.[60] It is important to note, however, that patients with bipolar disorder with a history of psychosis demonstrated greater impairment on measures of executive functioning and spatial working memory compared with bipolar patients without a history of psychosis[59] suggesting that psychotic symptoms are correlated with executive dysfunction.

TOC ← Previous Next →

Parkinson's disease

Parkinson's disease (PD) primarily involves damage to subcortical brain structures and is usually associated with movement difficulties, in addition to problems with memory and thought processes.[48] Persons affected by PD often demonstrate difficulties in working memory, a component of executive functioning. Cognitive deficits found in early PD process appear to involve primarily the fronto-executive functions.[61] Moreover, studies of the role of dopamine in the cognition of PD patients have suggested that PD patients with inadequate dopamine supplementation are more impaired in their performance on measures of executive functioning.[62] This suggests that dopamine may contribute to

executive control processes. Increased distractibility, problems in set formation and maintaining and shifting attentional sets, deficits in executive functions such as self-directed planning, problems solving, and working memory have been reported in PD patients.[61] In terms of working memory specifically, persons with PD show deficits in the areas of: a) spatial working memory; b) central executive aspects of working memory; c) loss of episodic memories; d) locating events in time.[48][61][62]

Spatial working memory. PD patients often demonstrate difficulty in updating changes in spatial information and often become disoriented. They do not keep track of spatial contextual information in the same way that a typical person would do almost automatically. Similarly, they often have trouble remembering the locations of objects that they have recently seen, and thus also have trouble with encoding this information into long-term memory.

Central executive aspects. PD is often characterized by a difficulty in regulating and controlling one's stream of thought, and how memories are utilized in guiding future behaviour. Also, persons affected by PD often demonstrate perseverative behaviours such as continuing to pursue a goal after it is completed, or an inability to adopt a new strategy that may be more appropriate in achieving a goal. However, some recent research suggests that PD patients may actually be less persistent in pursuing goals than typical persons and may abandon tasks sooner when they encounter problems of a higher level of difficulty.[61]

Loss of episodic memories. The loss of episodic memories in PD patients typically demonstrates a temporal gradient wherein older memories are generally more preserved than newer memories. Also, while forgetting event content is less compromised in Parkinson's than in Alzheimer's, the opposite is true for event data memories.

Locating events in time. PD patients often demonstrate deficits in their ability to sequence information, or date events. Part of the problems is hypothesized to be due to a more fundamental difficulty in coordinating or planning retrieval strategies, rather than failure at the level of encoding or storing information in memory. This deficit is also likely to be due to an underlying difficulty in properly retrieving script information. PD patients often exhibit signs of irrelevant intrusions, incorrect ordering of events, and omission of minor components in their script retrieval, leading to disorganized and inappropriate application of script information.

TOC ← Previous Next →

Treatment

TOC ← Previous Next →

Psychosocial treatment

Since 1997 there has been experimental and clinical practice of psychosocial treatment for adults with

executive dysfunction, and particularly attention-deficit/hyperactivity disorder (ADHD). Psychosocial treatment addresses the many facets of executive difficulties, and as the name suggests, covers academic, occupational and social deficits. Psychosocial treatment facilitates marked improvements in major symptoms of executive dysfunction such as time management, organization and self-esteem.[63]

TOC | Previous | Next

Cognitive-behavioral therapy and group rehabilitation

Cognitive-behavioural therapy (CBT) is a frequently suggested treatment for executive dysfunction, but has shown limited effectiveness. However, a study of CBT in a group rehabilitation setting showed a significant increase in positive treatment outcome compared with individual therapy. Patients' self-reported symptoms on 16 different ADHD/executive-related items were reduced following the treatment period.[64]

TOC | Previous | Next

Treatment for patients with acquired brain injury

The use of auditory stimuli has been examined in the treatment of dysexecutive syndrome. The presentation of auditory stimuli causes an interruption in current activity, which appears to aid in preventing "goal neglect" by increasing the patients' ability to monitor time and focus on goals. Given such stimuli, subjects no longer performed below their age group average IQ.[65]

Patients with acquired brain injury have also been exposed to goal management training (GMT). GMT skills are associated with paper-and-pencil tasks that are suitable for patients having difficulty setting goals. From these studies there has been support for the effectiveness of GMT and the treatment of executive dysfunction due to ABI.[66]

TOC | Previous | Next

Developmental context

An understanding of how executive dysfunction shapes development has implications how we conceptualize executive functions and their role in shaping the individual. Disorders affecting children such as ADHD, along with oppositional defiant disorder, conduct disorder, high functioning autism and Tourette's syndrome have all been suggested to involve executive functioning deficits.[67] The main focus of current research has been on working memory, planning, set shifting, inhibition, and fluency. This research suggests that differences exist between typically functioning, matched controls and clinical groups, on measures of executive functioning.[67]

Some research has suggested a link between a child's abilities to gain information about the world around them and having the ability to override emotions in order to behave appropriately.[68] One

study required children to perform a task from a series of psychological tests, with their performance used as a measure of executive function.[68] The tests included assessments of: executive functions (self-regulation, monitoring, attention, flexibility in thinking), language, sensorimotor, visuospatial, and learning, in addition to social perception. The findings suggested that the development of theory of mind in younger children is linked to executive control abilities with development impaired in individuals who exhibit signs of executive dysfunction.[68]

Both ADHD and obesity are complicated disorders and each produces a large impact on an individual's social well being.[69] This being both a physical and psychological disorder has reinforced that obese individuals with ADHD need more treatment time (with associated costs), and are at a higher risk of developing physical and emotional complications.[69] The cognitive ability to develop a comprehensive self-construct and the ability to demonstrate capable emotion regulation is a core deficit observed in people with ADHD and is linked to deficits in executive function.[69] Overall, low executive functioning seen in individuals with ADHD has been correlated with tendencies to overeat, as well as with emotional eating.[69] This particular interest in the relationship between ADHD and obesity is rarely clinically assessed and may deserve more attention in future research.

It has been made known that young children with behavioral problems show poor verbal ability and executive functions.[70] The exact distinction between parenting style and the importance of family structure on child development is still somewhat unclear. However, in infancy and early childhood, parenting is among the most critical external influences on child reactivity.[71] In Mahoney's study of maternal communication, results indicated that the way mothers interacted with their children accounted for almost 25% of variability in children's rate of development.[72] Every child is unique, making parenting an emotional challenge that should be most closely related to the child's level of emotional self-regulation (persistence, frustration and compliance).[71] A promising approach that is currently being investigated amid intellectually disabled children and their parents is responsive teaching. Responsive teaching is an early intervention curriculum designed to address the cognitive, language, and social needs of young children with developmental problems.[73] Based on the principle of "active learning",[73] responsive teaching is a method that is currently being applauded as adaptable for individual caregivers, children and their combined needs[72] The effect of parenting styles on the development of children is an important area of research that seems to be forever ongoing and altering. There is no doubt that there is a prominent link between parental interaction and child development but the best child rearing technique continues to vary amongst experts.

☰ TOC | ← Previous | Next →

Evolutionary perspective

The prefrontal lobe controls two related executive functioning domains. The first is mediation of abilities involved in planning, problem solving, and understanding information, as well as engaging in working memory processes and controlled attention. In this sense, the prefrontal lobe is involved with dealing with basic, everyday situations, especially those involving metacognitive functions.[74] The second domain involves the ability to fulfill biological needs through the coordination of cognition and emotions which are both associated with the frontal and prefrontal areas.[74]

From an evolutionary perspective, it has been hypothesized that the executive system may have evolved to serve several adaptive purposes.[75] The prefrontal lobe in humans has been associated both with metacognitive executive functions and emotional executive functions.[74] Theory and evidence suggest that the frontal lobes in other primates also mediate and regulate emotion, but do not demonstrate the metacognitive abilities that are demonstrated in humans.[74] This uniqueness of the executive system to humans implies that there was also something unique about the environment of ancestral humans, which gave rise to the need for executive functions as adaptations to that environment.[75] Some examples of possible adaptive problems that would have been solved by the evolution of an executive system are: social exchange, imitation and observational learning, enhanced pedagogical understanding, tool construction and use, and effective communication.[75]

In a similar vein, some have argued that the unique metacognitive capabilities demonstrated by humans have arisen out of the development of a sophisticated language (symbolization) systems and culture.[74] Moreover, in a developmental context, it has been proposed that each executive function capability originated as a form of public behaviour directed at the external environment, but then became self-directed, and then finally, became private to the individual, over the course of the development of self-regulation.[75] These shifts in function illustrate the evolutionarily salient strategy of maximizing longer-term social consequences over near-term ones, through the development of an internal control of behaviour.[75]

Socio-cultural implications

Education

In the classroom environment, children with executive dysfunction typically demonstrate skill deficits that can be categorized into two broad domains: a) self-regulatory skills; and b) goal-oriented skills.[76] The table below is an adaptation of McDougall's[76] summary and provides an overview of specific executive function deficits that are commonly observed in a classroom environment. It also offers examples of how these deficits are likely to manifest in behaviour.

Self-regulatory skills

Goal-oriented skills

Teachers play a crucial role in the implementation of strategies aimed at improving academic success and classroom functioning in individuals with executive dysfunction. In a classroom environment, the goal of intervention should ultimately be to apply external control, as needed (e.g. adapt the environment to suit the child, provide adult support) in an attempt to modify problem behaviours or supplement skill deficits.[77] Ultimately, executive function difficulties should not be attributed to negative personality traits or characteristics (e.g. laziness, lack of motivation, apathy, and stubbornness) as these attributions are neither useful nor accurate.

Several factors should be considered in the development of intervention strategies. These include, but are not limited to: developmental level of the child, comorbid disabilities, environmental changes, motivating factors, and coaching strategies.[76][77] It is also recommended that strategies should take a proactive approach in managing behaviour or skill deficits (when possible), rather than adopt a reactive approach.[76] For example, an awareness of where a student may have difficulty throughout the course of the day can aid the teacher in planning to avoid these situations or in planning to accommodate the needs of the student.

People with executive dysfunction have a slower cognitive processing speed and thus often take longer to complete tasks than people who demonstrate typical executive function capabilities. This can be frustrating for the individual and can serve to impede academic progress. Disorders affecting children such as ADHD, along with oppositional defiant disorder, conduct disorder, high functioning autism and Tourette's syndrome have all been suggested to involve executive functioning deficits.[57] The main focus of current research has been on working memory, planning, set shifting, inhibition, and fluency. This research suggests that differences exist between typically functioning, matched controls and

clinical groups, on measures of executive functioning.[57]

Moreover, some people with ADHD report experiencing frequent feelings of drowsiness.[78] This can hinder their attention for lectures, readings, and completing assignments. Individuals with this disorder have also been found to require more stimuli for information processing in reading and writing.[57] Slow processing may manifest in behavior as signaling a lack of motivation on behalf of the learner. However, slow processing is reflective of an impairment of the ability to coordinate and integrate multiple skills and information sources.[78]

The main concern with individuals with autism regarding learning is in the imitation of skills.[57] This can be a barrier in many aspects such as learning about others intentions, mental states, speech, language, and general social skills.[57] Individuals with autism tend to be dependent on the routines that they have already mastered, and have difficulty with initiating new non-routine tasks. Although an estimated 25–40% of people with autism also have a learning disability, many will demonstrate an impressive rote memory and memory for factual knowledge.[57] As such, repetition is the primary and most successful method for instruction when teaching people with autism.[78]

Being attentive and focused for people with Tourette's syndrome is a difficult process. People affected by this disorder tend to be easily distracted and act very impulsively.[79] That is why it is very important to have a quiet setting with few distractions for the ultimate learning environment. Focusing is particularly difficult for those who are affected by Tourette's syndrome comorbid with other disorders such as ADHD or obsessive-compulsive disorder, it makes focusing very difficult.[79] Also, these individuals can be found to repeat words or phrases consistently either immediately after they are learned or after a delayed period of time.[79]

TOC | ← Previous | Next →

Criminal behaviour

Prefrontal dysfunction has been found as a marker for persistent, criminal behavior.[80] The prefrontal cortex is involved with mental functions including; affective range of emotions, forethought, and self-control.[80] Moreover, there is a scarcity of mental control displayed by individuals with a dysfunction in this area over their behavior, reduced flexibility and self-control and their difficulty to conceive behavioral consequences, which may conclude in unstable (or criminal) behavior.[80][81] In a recent study conducted by Barbosa & Monteiro, it was discovered that the recurrent criminals that were considered in this study suffered from executive dysfunction.[80] In view of the fact that abnormalities in executive function can limit how people respond to rehabilitation and re-socialization programs[80] these findings of the recurrent criminals are justified. Statistically significant relations have been

discerned between anti-social behavior and executive function deficits.[82] These findings relate to the emotional instability that is connected with executive function as a detrimental symptom that can also be linked towards criminal behavior. Conversely, it is unclear as to the specificity of anti-social behavior to executive function deficits as opposed to other generalized neuropsychological deficits.[82] The uncontrollable deficiency of executive function has an increased expectancy for aggressive behavior that can result in a criminal deed.[83][84] Orbitofrontal injury also hinders the ability to be risk avoidant, make social judgments, and may cause reflexive aggression.[83] A common retort to these findings is that the higher incidence of cerebral lesions among the criminal population may be due to the peril associated with a life of crime.[80] Along with this reasoning, it would be assumed that some other personality trait is responsible for the disregard of social acceptability and reduction in social aptitude.

Furthermore, some think the dysfunction cannot be entirely to blame.[83] There are interacting environmental factors that also have an influence on the likelihood of criminal action. This theory proposes that individuals with this deficit are less able to control impulses or foresee the consequences of actions that seem attractive at the time (see above) and are also typically provoked by environmental factors. One must recognize that the frustrations of life, combined with a limited ability to control life events, can easily cause aggression and/or other criminal activities.

See also

- Autonoetic consciousness

TOC Previous

References

1. ^ [a] [b] [c] [d] [e] [f] [g] [h] Elliott R (2003). Executive functions and their disorders. British Medical Bulletin. (65); 49–59
2. ^ Wilson, B.A., Evans, J.J., Emslie, H., Alderman, N., & Burgess, P. (1998). The development of an ecologically valid test for assessing patients with a dysexecutive syndrome. *Neuropsychological Rehabilitation, 8,* 213-228.
3. ^ Baddeley, A., & Wilson, B. (1988). Frontal amnesia and the dysexecutive syndrome. *Brain and Cognition*, *7*, 212-230.
4. ^ Halligan, P.W., Kischka, U., & Marshall, J.C. (2004). *Handbook of clinical neuropsychology*. Oxford University Press.
5. ^ Stuss, D.T. & Alexander, M.P. (2007). Is there a dysexecutive syndrome? *Philosophical transactions of the Royal Society of London. Series B, Biological Sciences, 362* (1481), 901-15.
6. ^ Jurado MB, Rosselli M (2007). The elusive nature of executive functions: a review of our current understanding. Neuropsychol Rev, 17(3):213–33.
7. ^ Schmeichel, BJ (2007). Attention Control, memory updating, and emotion regulation temporarily reduce the capacity for executive control. Journal of Experimental Psychology: General, 136(2):241–55
8. ^ Zelazo PD, Craik FI, Booth L (2004). Executive function across the life span. Acta Psychol (Amst), 115 (2–3):167–83.
9. ^ Bisiacchi PS, Borella E, Bergamaschi S, Carretti B, Mondini S (2008). Interplay between memory and executive functions in normal and pathological aging. J Clin Exp Neuropsychol, 30(6):723–33.
10. ^ Nieuwenhuis S, Broerse A, Nielen MM, de Jong R (2004). A goal activation approach to the study of executive function: an application to antisaccade tasks. Brain Cogn. 56(2):198–214. Review.
11. ^ [a] [b] Verbruggen F, Logan GD. (2008). Long-term aftereffects of response inhibition: memory retrieval, task goals, and cognitive control. J Exp Psychol Hum Percept Perform, 34(5):1229–35.
12. ^ Avila C, Barros A, Ortet G, Parcet MA & Ibanez M I (2003). Set-shifting and sensitivity to reward: A possible dopamine mechanism for explaining disinhibitory disorders. Cognition and Emotion, 17, 951–59.
13. ^ Schmeichel BJ, Volokhov RN & Demaree HA (2008). Working memory capacity and the Self-Regulation of Emotional Expression and Experience" *Journal of Personality and Social Psychology* 95(6), 1526–40.

14. ^ *a b c d e* Barkley RA (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD" *Psychological Bulletin* 121(1), 65–94
15. ^ Hoffmann MW, & Bill PLA (1992). The environmental dependency syndrome, imitation behaviour and utilization behaviour as presenting symptoms of bilateral frontal lobe infarction due to moyamoya disease. South African medical journal, 81(5): 271–73
16. ^ Perrotin A, Tournell L, Isingrini M (2008). Executive functioning and memory as potential mediators of the episodic feeling-of-knowing accuracy" *Brain and Cognition* 67:76–87.
17. ^ *a b* Abraham, A; Windmann, S; McKenna, P; Güntürkün, O (May 2007). "Creative thinking in schizophrenia: the role of executive dysfunction and symptom severity". *Cognitive Neuropsychiatry*. **12** (3): 235–58. doi:10.1080/13546800601046714. PMID 17453904.
18. ^ Keshavan MS, Sujata M, Mehra A, Montrose DM, Sweeney JA (2003). Psychosis proneness and ADHD in young relatives of schizophrenia patients. Schizophrenia Research, 59(1), 85–92.
19. ^ *a b c* Nigg JT (2006). What causes ADHD?: Understanding what goes wrong and why. New York, NY: Guilford Press. ISBN 1-59385-267-3, ISBN 978-1-59385-267-2.
20. ^ *a b* Clark C, Gallo J, Glosser G, Grossman M (2002). Memory encoding and retrieval in frontotemporal dementia and Alzheimer's disease. Neuropsychology. 16(2); 190–96
21. ^ Berquin PC, Giedd JN, Jacobsen LK, Hamburger SD, Krain AL, Rapoport JL, Castellanos FX (1998). Cerebellum in attention-deficit hyperactivity disorder: A morphometric MRI study" *Neurology* 50, 1087–93.
22. ^ *a b c* Carpenter P, Just M & Reichle E (2000). Working memory and executive function: evidence from neuroimaging. Current Opinion in Neurobiology. 10; 195–99
23. ^ *a b c d* Dougherty D, Ottowitz W, Savage C (2002). Neural network basis for abnormalities of attention and executive function in major depressive disorder: implications for application of the medical disease model to psychiatric disorders. Harvard Review of Psychology. 10(2); 86–99
24. ^ Caparelli E, Chang L, Ernst T et al. (2006). Different activation patterns for working memory load and visual attention load. Brain Research. 158–65
25. ^ Buckner, R. (2004). Memory and executive function in aging and AD: multiple factors that cause decline and reserve factors that compensate" *Neuron* 44;195–208
26. ^ Friedman, et al (2008). Individual differences in executive functions are almost entirely genetic in origin. Journal of experimental psychology, 137(2), 201–10.
27. ^ Langley K, Marshall L, Bree M van den, Thomas H, Owen M, O'Donovan M, Thapar A (2004). Association of the dopamine D4 receptor gene 7-repeat allele with neuropsychological test performance of children with ADHD" *American Journal of Psychiatry* 161(1),133–38.
28. ^ Tunbridge EM, Bannerman DM, Sharp T, Harrison PJ (2004). Catechol-o-methyltransferase

inhibition improves set-shifting performance and elevates stimulated dopamine release in the rat prefrontal cortex" *Journal of Neuroscience* 24(23):5331–35.

29. ^ Sengupta S, Grizenko N, Schmitz N, Schwartz G, Bellingham J, Polotskaia A, Stepanian MT, Goto Y, Grace AA, Joober R (2008). COMT Val108/158Met polymorphism and the modulation of task-oriented behavior in children with ADHD" *Neuropsychopharmacology* 2008, 13:3069–77.
30. ^ ***a b*** Alfimova MV, Golimbet VE, Gritsenko IK, Lezheiko TV, Abramova LI, Strel'tsova MA, Khlopina IV, Ebstein R (2007). Interaction of dopamine system genes and cognitive functions in patients with schizophrenia and their relatives and in healthy subjects from the general population. Neuroscience Behaviour Physiology, 37(7), 643–50.
31. ^ Daghar A, Monchi O, Petre V et al (2001). "Wisconsin card revisited: distinct neural circuits participating in different stages of the task identified by event-related functional magnetic resonance imaging." *The Journal of Neuroscience* 21(19)
32. ^ ***a b c*** Shulman, K (2000). Clock drawing: Is it the ideal cognitive screening test? International Journal of Geriatric Psychiatry. 15(6); 548–61
33. ^ Emond J, Galasko D, Hanson L. et al (2008). Spatial deficits predict rate of cognitive decline in autopsy-verified dementia with lewy bodies. Neuropsychology. 22(6); 729–37
34. ^ Jeste DV, Legendre SA, Rice VA, et al (2004). "The clock drawing test as a measure of executive dysfunction in elderly depressed patients." Journal of Geriatric Psychiatry and Neurology. 17(190)
35. ^ Damasio H, Rudrauf D, Tranel D, Vianna E (2008). Does the clock drawing test have focal neuroanatomical correlates? Neuropsychology. 22(5); 553–62
36. ^ ***a b c d*** Biederam J, Faraone S, Monutaeux M, et al (2000). Neuropsychological functioning in nonreferred siblings of children with attention deficit/hyperactivity disorder" *Journal of Abnormal Psychology* 109(2); 252–65
37. ^ MacLeod C (1991). Half a century of research on the Stroop effect: An integrative review" *Psychological Bulletin* 109(20); 163–203
38. ^ de Young R (2009)." Stroop task: A test of capacity to direct attention." EPLab: Measures. University of Michigan; http://www.snre.umich.edu/eplab/demos/st0/stroopdesc.html
39. ^ Andermahr I, Gaser C, Hager F et al (1996). Brain activation during cognitive stimulation with the Wisconsin Card Sorting test—a functional MRI study on healthy volunteers and schizophrenics. Psychiatry Research: Neuroimaging. 75(3); 145–57
40. ^ Kirkham, N. Z.; Cruess, L.; Diamond, A. (2003). "Helping children apply their knowledge to their behavior on a dimension-switching task". *Developmental Science*. **6**: 449–476. doi:10.1111/1467-7687.00300.

41. ^ Chelune, G. J.; Baer, R. A. (1986). "Developmental norms for the Wisconsin Card Sorting Test". *Journal of Clinical and Experimental Neuropsychology*. **8**: 219–228. doi:10.1080/01688638608401314.
42. ^ *a b* Arbuthnott K, Frank J (2000). Trail making test, Part B as a measure of executive control: validation using a set-switching paradigm. Journal of Clinical and Experimental Neuropsychology. 22(4); 518–28
43. ^ Gaudino E, Geisler M, Squires N (1995). Construct validity in the trail making test: What makes part B harder? Journal of Clinical and Experimental Neuropsychology. 17(4); 529–35
44. ^ *a b* Conn H (1977). Trail-making and number-connection tests in the assessment of mental state in portal systemic encephalopathy. Digestive Diseases. 22(6); 541–50
45. ^ Chan, RC. (2001). Dysexecutive symptoms among a non-clinical sample: a study with the use of the Dysexecutive Questionnaire. British Journal of Psychology, Aug., 92 (pt 3):551–65.
46. ^ *a b* Lhermitte F (1986). Human autonomy and the frontal lobes. Part II: Patient behavior in complex and social situations: the "environmental dependency syndrome" *Annals of Neurology* 19(4):335–43.
47. ^ Hoffmann M (2007). Transient environmental dependency syndrome due to phendimetrazine tartrate. Eur Neurol, 58(1):49–50.
48. ^ *a b c d e f g h* Ward J (2006). The Student's Guide to Cognitive Neuroscience. New York: Psychology Press
49. ^ *a b* Oram J, Geffen GM, Geffen LB, Kavanaugh DJ & McGrath JJ (2005). Executive control of working memory in schizophrenia" *Psychiatry Research* 135, 8190
50. ^ Thoma P & Duam I (2008). Working memory and multi-tasking in paranoid schizophrenia with and without comorbid substance use disorder" *Addiction* 103, 774–86.
51. ^ Radvansky GA (2006). Human Memory. United States of America: Allyn and Bacon
52. ^ *a b c d* Marchetta N, Hurks P, Krabbendam L & Jolles J (2008). Interference control, working memory, concept shifting, and verbal fluency in adults with attention-deficit/hyperactivity disorder (ADHD). Neruopsychology, 22(1), 74–84
53. ^ *a b c* Rosenman S (2006). Reconsidering the attention deficit paradigm. Australasian Psychiatry, 14(2), 127–32
54. ^ *a b* Barnard L, Muldoon K, Hasan R, O'Brien G & Stewart M (2008). Profiling executive dysfunction in adults with autism and comorbid learning disability. Autism, 12(2), 125–41
55. ^ Gilotty L, Kenworthy L, Sirian L, Black D & Wagner A (2002). Adaptive skills and executive function in autism spectrum disorders. Child Neuropsychology, 8(4), 241–48
56. ^ *a b c* Firestone P & Dozois JA (2007). Abnormal Psychology: Perspectives (3rd edition.). Toronto: Pearson Education Canada Inc.

57. ^ *a b c d e f g h i j* Hill EL (2004). Executive dysfunction in autism. Trends in Cognitive Sciences, 8(1), 26–32
58. ^ *a b c* Robinson LJ, Thompson JM, Gallagher P, Goswami U, Young AH, Ferrier IN & Moore PB (2006). A meta-analysis of cognitive deficits in euthymic patients with bipolar disorder" *Journal of Affective Disorders* 93, 105–15
59. ^ *a b* Glahn DC, Bearden CE, Barguil M, Barrett J, Reichenberg A, Bowden CL, Soars JC & Velligan DI (2007). The neurocognitive signature of psychotic bipolar disorder. Journal of Biology Psychiatry, 62, 910–16
60. ^ *a b* Dixon T, Kravariti E, Frith C, Murray RM & McGuire PK (2004). Effect of symptoms on executive function in bipolar illness" *Psychological Medicine* 34, 81–82.
61. ^ *a b c d* Schneider JS (2007). Behavioral persistence deficit in Parkinson's disease patients. Journal of Neurology, 14, 300–04
62. ^ *a b* Grossman M, Lee C, Morris J, Stern MB & Hurtig H (2002). Assessing resource demands during sentence processing in Parkinson's disease. Brain and Language, 80, 603–16
63. ^ Ramsay JR & Rostain AL (2007). Psychosocial treatments for attention-deficit/hyperactivity disorder in adults: Current status and future directions. Journal of Attention Disorders, 11(6), 624–27
64. ^ Virta M, Vedenpää A, Grönroos N, Chydenius E, Partinen M, Vataja R, Kaski M, Iivanainen M (2008). Adults with ADHD benefit from cognitive-behaviorally oriented group rehabilitation: a study of 29 participants. Journal of Attention Disorders, 12(3), 218–26
65. ^ Manly T, Hawkins K, Evans J, Woldt K, Robertson IH (2002). Rehabilitation of executive function: facilitation of effective goal management on complex tasks using periodic auditory alerts" *Neuropsychologia* 40(3):271–81
66. ^ Levine B, Robertson IH, Clare L, Carter G & Hong J (2000). Rehabilitation of executive functioning: An experimental–clinical validation of Goal Management Training. Journal of the International Neuropsychological Society, 6: 299–312
67. ^ *a b* De Boechorstraat V, Geurts H, Oosterlaan J et al (2001). How specific is a deficit of executive functioning for attention-deficit/hyperactivity disorder? Amsterdam
68. ^ *a b c* Barchfeld P, Kain W, Perner J (2002). Executive control and higher-order theory of mind in children at risk at ADHD. Austria: Department of Psychology, University of Salzburg
69. ^ *a b c d* Dempsey A, Dyehouse J (2008). The relationship between executive function, AD/HD, and obesity. Western Journal of Nursing Research. 30(8); 1026–27
70. ^ Ensor R, Hughes C (2006). Behavioral problems in 2-year-olds: links with individual differences in theory of mind, executive function and harsh parenting" *Journal of Child Psychology and Psychiatry* 47(5); 488–97

71. ^ a b Dennis T (2006). Self-regulation in preschools: the interplay of child approach reactivity, parenting and control capacities" *Developmental Psychology* 42(1); 84–97
72. ^ a b Mahoney GJ (1988). Maternal communication style with mentally retarded children. American Journal of Mental Retardation, 93; 352–59
73. ^ a b Herman B, Mahoney G, Perales F et al (2006). Responsive teaching: early intervention for children with down syndrome and other disabilities. Down Syndrome Research and Practice
74. ^ a b c d e Ardila A (2008). On the evolutionary origins of executive functions. Department of Communication Sciences and Disorders, Florida International University
75. ^ a b c d e Barkley RA (2001). The executive functions and self-regulation: An evolutionary neuropsychological perspective. Neuropsychology Review, 11(1), 1–29
76. ^ a b c d McDougall A (2001). Executive functions: Practical strategies for supporting students. Psychological Services, DDSB. Symposium conducted at DDSB, Ontario, Canada.
77. ^ a b Lerner JW & Kline F (2006). Learning disabilities and related disorders: Characteristics and teaching strategies (10th ed.). United States of America: Houghton Mifflin
78. ^ a b c Brown TE (2008). Describing Six Aspects of a Complex Syndrome. http://www.drthomasebrown.com/pdfs/Executive_Functions_by_Thomas_Brown.pdf
79. ^ a b c Gaffney GR (2005). Tourette Syndrome. University of Iowa Hospital and Clinics. http://www.uihealthcare.com/topics/neurologicalhealth/tourettesyndrome.html [*dead link*]
80. ^ a b c d e f Barbosa M, Monteiro L (2008). Recurrent criminal behaviour and executive dysfunction. The Spanish Journal of Psychology, 259–65
81. ^ Ogilvie, James M.; Stewart, Anna L.; Chan, Raymond C. K.; Shum, David H. K. (2011-11-01). "Neuropsychological Measures of Executive Function and Antisocial Behavior: A Meta-Analysis*". *Criminology*. **49** (4): 1063–1107. doi:10.1111/j.1745-9125.2011.00252.x. ISSN 1745-9125.
82. ^ a b Lilenfeld S, Morgan A (2000). A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. Clinical Psychology Review. 20(1); 113–36
83. ^ a b c Brower MC, Price BH (2001). Neuropsychiatry of frontal lobe dysfunction in violent and criminal behaviour: a critical review. Advances in Neuropsychiatry. 720–26
84. ^ Meijers, J.; Harte, J. M.; Meynen, G.; Cuijpers, P. (2017-02-01). "Differences in executive functioning between violent and non-violent offenders". *Psychological Medicine*: 1–10. doi:10.1017/S0033291717000241. ISSN 0033-2917.

Categories: Self | Neuropsychology | Neuropsychological assessment | Cognitive science | Attention deficit hyperactivity disorder | Motor control | Autism

Contents

Cognitive Computing

Jump to navigation Jump to search

Cognitive computing (**CC**) describes technology platforms that, broadly speaking, are based on the scientific disciplines of artificial intelligence and signal processing. These platforms encompass machine learning, reasoning, natural language processing, speech recognition and vision (object recognition), human–computer interaction, dialog and narrative generation, among other technologies.[1][2]

TOP

TOC Next

Definition

At present, there is no widely agreed upon definition for cognitive computing in either academia or industry.[1][3][4]

In general, the term cognitive computing has been used to refer to new hardware and/or software that mimics the functioning of the human brain[5][6][7][8][9][10] (2004) and helps to improve human decision-making.[11][12] In this sense, CC is a new type of computing with the goal of more accurate models of how the human brain/ mind senses, reasons, and responds to stimulus. CC applications link data analysis and adaptive page displays (AUI) to adjust content for a particular type of audience. As such, CC hardware and applications strive to be more affective and more influential by design.

Some features that cognitive systems may express are:

- **Adaptive**: They may learn as information changes, and as goals and requirements evolve. They may resolve ambiguity and tolerate unpredictability. They may be engineered to feed on dynamic data in real time, or near real time.[13]
- **Interactive**: They may interact easily with users so that those users can define their needs comfortably. They may also interact with other processors, devices, and Cloud services, as well as with people.
- **Iterative and stateful**: They may aid in defining a problem by asking questions or finding additional source input if a problem statement is ambiguous or incomplete. They may "remember" previous interactions in a process and return information that is suitable for the specific application at that point in time.
- **Contextual**: They may understand, identify, and extract contextual elements such as meaning, syntax, time, location, appropriate domain, regulations, user’s profile, process, task and goal. They may draw on multiple sources of information, including both structured and unstructured digital information, as well as sensory inputs (visual, gestural, auditory, or sensor-provided).[14]

Use cases

- Speech recognition
- Sentiment analysis
- Face detection
- Risk assessment
- Fraud detection
- Behavioral recommendations

TOC Previous Next

Cognitive analytics

Cognitive computing-branded technology platforms typically specialize in the processing and analysis of large, unstructured datasets[15][16].

Word processing documents, emails, videos, images, audio files, presentations, webpages, social media and many other data formats often need to be manually tagged with metadata before they can be fed to a computer for analysis and insight generation. The principal benefit of utilizing cognitive analytics over traditional big data analytics is that such datasets do not need to be pretagged.

Other characteristics of a cognitive analytics system include:

- **Adaptability:** cognitive analytics systems can use machine learning to adapt to different contexts with minimal human supervision
- **Natural language interaction:** cognitive analytics systems can be equipped with a chatbot or search assistant that understands queries, explains data insights and interacts with humans in natural language.

TOC | Previous | Next

See also

- Affective computing
- Analytics
- Artificial neural network
- Cognitive computer
- Cognitive reasoning
- Enterprise cognitive system
- Social neuroscience
- Synthetic intelligence
- Usability

TOC Previous Next

References

1. ^ a b *Kelly III, Dr. John (2015). "Computing, cognition and the future of knowing" (PDF). IBM Research: Cognitive Computing. IBM Corporation. Retrieved February 9, 2016.*
2. ^ Augmented intelligence, helping humans make smarter decisions. Hewlett Packard Enterprise. http://h20195.www2.hpe.com/V2/GetPDF.aspx/4AA6-4478ENW.pdf
3. ^ *"IBM Research: Cognitive Computing"*.
4. ^ *"Cognitive Computing"*.
5. ^ *"Hewlett Packard Labs"*.
6. ^ Terdiman, Daniel (2014) .IBM's TrueNorth processor mimics the human brain.http://www.cnet.com/news/ibms-truenorth-processor-mimics-the-human-brain/
7. ^ Knight, Shawn (2011). *IBM unveils cognitive computing chips that mimic human brain* TechSpot: August 18, 2011, 12:00 PM
8. ^ Hamill, Jasper (2013). *Cognitive computing: IBM unveils software for its brain-like SyNAPSE chips* The Register: August 8, 2013
9. ^ *Denning. P.J. (2014). "Surfing Toward the Future". Communications of the ACM.* ***57*** *(3): 26–29. doi:10.1145/2566967.*
10. ^ *Dr. Lars Ludwig (2013). "Extended Artificial Memory. Toward an integral cognitive theory of memory and technology" (pdf). Technical University of Kaiserslautern. Retrieved 2017-02-07.*
11. ^ *"Research at HP Labs"*.
12. ^ *"Automate Complex Workflows Using Tactical Cognitive Computing: Coseer". thesiliconreview.com. Retrieved 2017-07-31.*
13. ^ Ferrucci, D. et al. (2010) Building Watson: an overview of the DeepQA Project. Association for the Advancement of Artificial Intelligence, Fall 2010, 59–79.
14. ^ Deanfelis, Stephen (2014). *Will 2014 Be the Year You Fall in Love With Cognitive Computing?* Wired: 2014-04-21
15. ^ *"Cognitive analytics - The three-minute guide" (PDF). 2014. Retrieved 2017-08-18.*

16. ^ "What is cognitive analytics? - Quora". *www.quora.com.* *Retrieved 2017-08-18.*

TOC Previous

Further reading

- *Russell, John (2016-02-15). "Mapping Out a New Role for Cognitive Computing in Science". HPCwire. Retrieved 2016-04-21.*

Categories:

- Cognitive science
- Artificial intelligence

This page was last edited on 22 March 2018, at 13:37.

Back to main TOC

Contents

Mental Model

Jump to navigation Jump to search
For other uses, see Mind model.

A **mental model** is an explanation of someone's thought process about how something works in the real world. It is a representation of the surrounding world, the relationships between its various parts and a person's intuitive perception about his or her own acts and their consequences. Mental models can help shape behaviour and set an approach to solving problems (similar to a personal algorithm) and doing tasks.

A mental model is a kind of internal symbol or representation of external reality, hypothesized to play a major role in cognition, reasoning and decision-making. Kenneth Craik suggested in 1943 that the mind constructs "small-scale models" of reality that it uses to anticipate events.

Jay Wright Forrester defined general mental models as:

In psychology, the term *mental models* is sometimes used to refer to mental representations or mental simulation generally. At other times it is used to refer to § Mental models and reasoning and to the mental model theory of reasoning developed by Philip Johnson-Laird and Ruth M.J. Byrne.

TOP

TOC Next

History

The term *mental model* is believed to have originated with Kenneth Craik in his 1943 book *The Nature of Explanation*.[1][2] Georges-Henri Luquet in *Le dessin enfantin* (Children's drawings), published in 1927 by Alcan, Paris, argued that children construct internal models, a view that influenced, among others, child psychologist Jean Piaget.

Philip Johnson-Laird published *Mental Models: Towards a Cognitive Science of Language, Inference and Consciousness* in 1983. In the same year, Dedre Gentner and Albert Stevens edited a collection of chapters in a book also titled *Mental Models*.[3] The first line of their book explains the idea further: "One function of this chapter is to belabor the obvious; people's views of the world, of themselves, of their own capabilities, and of the tasks that they are asked to perform, or topics they are asked to learn, depend heavily on the conceptualizations that they bring to the task." (see the book: *Mental Models*).

Since then, there has been much discussion and use of the idea in human-computer interaction and usability by researchers including Donald Norman and Steve Krug (in his book *Don't Make Me Think*). Walter Kintsch and Teun A. van Dijk, using the term *situation model* (in their book *Strategies of Discourse Comprehension*, 1983), showed the relevance of mental models for the production and comprehension of discourse.

Mental models and reasoning

One view of human reasoning is that it depends on mental models. In this view, mental models can be constructed from perception, imagination, or the comprehension of discourse (Johnson-Laird, 1983). Such mental models are similar to architects' models or to physicists' diagrams in that their structure is analogous to the structure of the situation that they represent, unlike, say, the structure of logical forms used in formal rule theories of reasoning. In this respect, they are a little like pictures in the picture theory of language described by philosopher Ludwig Wittgenstein in 1922. Philip Johnson-Laird and Ruth M.J. Byrne developed a theory of mental models which makes the assumption that reasoning depends, not on logical form, but on mental models (Johnson-Laird and Byrne, 1991).

TOC Previous Next

Principles of mental models

Mental models are based on a small set of fundamental assumptions (axioms), which distinguish them from other proposed representations in the psychology of reasoning (Byrne and Johnson-Laird, 2009). Each mental model represents a possibility. A mental model represents one possibility, capturing what is common to all the different ways in which the possibility may occur (Johnson-Laird and Byrne, 2002). Mental models are iconic, i.e., each part of a model corresponds to each part of what it represents (Johnson-Laird, 2006). Mental models are based on a principle of truth: they typically represent only those situations that are possible, and each model of a possibility represents only what is true in that possibility according to the proposition. However, mental models can represent what is false, temporarily assumed to be true, for example, in the case of counterfactual conditionals and counterfactual thinking (Byrne, 2005).

TOC Previous Next

Reasoning with mental models

People infer that a conclusion is valid if it holds in all the possibilities. Procedures for reasoning with mental models rely on counter-examples to refute invalid inferences; they establish validity by ensuring that a conclusion holds over all the models of the premises. Reasoners focus on a subset of the possible models of multiple-model problems, often just a single model. The ease with which reasoners can make deductions is affected by many factors, including age and working memory (Barrouillet, et al., 2000). They reject a conclusion if they find a counterexample, i.e., a possibility in which the premises hold, but the conclusion does not (Schroyens, et al. 2003; Verschueren, et al., 2005).

TOC Previous Next

Criticisms

Scientific debate continues about whether human reasoning is based on mental models, versus formal rules of inference (e.g., O'Brien, 2009), domain-specific rules of inference (e.g., Cheng & Holyoak, 2008; Cosmides, 2005), or probabilities (e.g., Oaksford and Chater, 2007). Many empirical comparisons of the different theories have been carried out (e.g., Oberauer, 2006).

TOC Previous Next

Mental models of dynamics systems: mental models in system dynamics

TOC Previous Next

Characteristics

A mental model is generally:

- founded on unquantifiable, impugnable, obscure, or incomplete facts
- **flexible** – is considerably variable in positive as well as in negative sense
- an **information filter** – causes selective perception, perception of only selected parts of information
- **very limited**, compared with the complexities of the world, and even when a scientific model is extensive and in accordance with a certain reality in the derivation of logical consequences of it, it must take into account such restrictions as working memory; i.e., rules on the maximum number of elements that people are able to remember, gestaltisms or failure of the principles of logic, etc.
- dependent on sources of information, which one can not find anywhere else, are available at any time and can be used.[4][5][6]

Mental models are a fundamental way to understand organizational learning. Mental models, in popular science parlance, have been described as "deeply held images of thinking and acting".[7] Mental models are so basic to understanding the world that people are hardly conscious of them.

TOC Previous Next

Expression of mental models of dynamic systems

S.N. Groesser and M. Schaffernicht (2012) describe three basic methods which are typically used:

- Causal loop diagrams – displaying tendency and a direction of

information connections and the resulting causality and feedback loops
- System structure diagrams – another way to express the structure of a qualitative dynamic system
- Stock and flow diagrams - a way to quantify the structure of a dynamic system

These methods allow showing a mental model of a dynamic system, as an explicit, written model about a certain system based on internal beliefs. Analyzing these graphical representations has been an increasing area of research across many social science fields.[8] Additionally software tools that attempt to capture and analyze the structural and functional properties of individual mental models such as Mental Modeler, "a participatory modeling tool based in fuzzy-logic cognitive mapping",[9] have recently been developed and used to collect/compare/combine mental model representations collected from individuals for use in social science research, collaborative decision-making, and natural resource planning.

TOC | Previous | Next

Mental model in relation to system dynamics and systemic thinking

In the simplification of reality, creating a model can find a sense of reality, seeking to overcome systemic thinking and system dynamics.

These two disciplines can help to construct a better coordination with the reality of mental models and simulate it accurately. They increase the probability that the consequences of how to decide and act in accordance with how to plan.[4]

- **System dynamics** – extending mental models through the creation of explicit models, which are clear, easily communicated and can be compared with each other.
- **Systemic thinking** – seeking the means to improve the mental models and thereby improve the quality of dynamic decisions that are based on mental models.

Single and double-loop learning

After analyzing the basic characteristics, it is necessary to bring the process of changing the mental models, or the process of learning. Learning is a back-loop process, and feedback loops can be illustrated as: single-loop learning or double-loop learning.

TOC Previous Next

Single-loop learning

Mental models affect the way people work with the information and determine the final decision. The decision itself changes, but the mental models remain the same. It is the predominant method of learning, because it is very convenient. One established mental model is fixed, so the next decision is very fast.

TOC Previous

Double-loop learning

Main article: Double-loop learning

Double-loop learning (*see diagram below*) is used when it is necessary to change the mental model on which a decision depends. Unlike single loops, this model includes a shift in understanding, from simple and static to broader and more dynamic, such as taking into account the changes in the surroundings and the need for expression changes in mental models.[5]

See also

- Cognitive map
- Cognitive psychology
- Conceptual model
- Educational psychology
- Folk psychology
- Internal model (motor control)
- Knowledge representation
- Lovemap
- Macrocognition
- Map–territory relation
- Model-dependent realism
- Neuro-linguistic programming
- Neuroeconomics
- Neuroplasticity
- OODA loop
- Psyche (psychology)
- Self-stereotyping
- Social intuitionism
- Space mapping
- System dynamics
- Text and conversation theory

TOC Previous Next

Notes

1. ^ *Nersessian, Nancy J. (1992). "In the Theoretician's Laboratory: Thought Experimenting as Mental Modeling" (PDF). PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association. **1992**: 291–301. doi:10.1086/psaprocbienmeetp.1992.2.192843. Retrieved 17 July 2014. "The contemporary notion that mental modelling plays a significant role in human reasoning was formulated, initially, by Kenneth Craik in 1943."*
2. ^ *Staggers, Nancy; Norcio, A.F. (1993). "Mental models: concepts for human-computer interaction research" (PDF). International Journal of Man-Machine Studies. **38** (4): 587–605. doi:10.1006/imms.1993.1028. Retrieved 17 July 2014. "Although Johnson-Laird (1989) is generally credited with coining the term mental model, the history of the concept may be traced to Craik's (1943) work entitled The Nature of Explanation."*
3. ^ "Mental models", report at www.lauradove.info.
4. ^ *a b* *Šusta, Marek. "Několik slov o systémové dynamice a systémovém myšlení" (PDF) (in Czech). Proverbs, a.s. pp. 3–9. Retrieved 2009-01-15.*
5. ^ *a b* *Mildeova, S., Vojtko V. (2003). Systémová dynamika (in Czech). Prague: Oeconomica. pp. 19–24. ISBN 80-245-0626-2.*
6. ^ *Ford, David N., Sterman, John D. "Expert Knowledge Elicitation to Improve Mental and Formal Models" (PDF). Cambridge, Massachusetts, US - Massachusetts Institute of Technology. pp. 18–23. Retrieved 2009-01-11.*
7. ^ "Leading for a Change", Ralph Jacobson, 2000, Chapter 5, Page102
8. ^ *Natalie, Jones,; Helen, Ross,; Timothy, Lynam,; Pascal, Perez,; Anne, Leitch, (24 March 2011). "Mental Models: An Interdisciplinary Synthesis of Theory and Methods". Ecology and Society. **16** (1). doi:10.5751/ES-03802-160146. Retrieved 11 April 2018.*
9. ^ *"Mental Modeler: A Fuzzy-Logic Cognitive Mapping Modeling Tool for Adaptive Environmental Management" (PDF). mentalmodeler.org. Retrieved 11 April 2018.*

References

- Barrouillet, P. et al. (2000). Conditional reasoning by mental models: chronometric and developmental evidence. *Cognit*. 75, 237-266.
- Byrne, R.M.J. (2005). *The Rational Imagination: How People Create Counterfactual Alternatives to Reality*. Cambridge MA: MIT Press.
- Byrne, R.M.J. & Johnson-Laird, P.N. (2009). 'If' and the problems of conditional reasoning. *Trends in Cognitive Sciences*. 13, 282-287
- Cheng, P.C. and Holyoak, K.J. (2008) Pragmatic reasoning schemas. In *Reasoning: studies of human inference and its foundations* (Adler, J.E. and Rips, L.J., eds), pp. 827–842, Cambridge University Press
- Cosmides, L. et al. (2005) Detecting cheaters. *Trends in Cognitive Sciences*. 9,505–506
- Forrester, J. W. (1971) Counterintuitive behavior of social systems. *Technology Review*.
- Oberauer K. (2006) Reasoning with conditionals: A test of formal models of four theories. *Cognit. Psychol*. 53:238–283.
- O'Brien, D. (2009). Human reasoning includes a mental logic. *Behav. Brain Sci*. 32, 96–97
- Oaksford, M. and Chater, N. (2007) *Bayesian Rationality*. Oxford University Press
- Johnson-Laird, P.N. (1983). *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*. Cambridge: Cambridge University Press.
- Johnson-Laird, P.N. (2006) *How We Reason*. Oxford University Press
- Johnson-Laird, P.N. and Byrne, R.M.J. (2002) Conditionals: a theory of meaning, inference, and pragmatics. *Psychol. Rev*. 109, 646–678
- Schroyens, W. et al. (2003). In search of counterexamples: Deductive rationality in human reasoning. *Quart. J. Exp. Psychol*. 56(A), 1129–1145.
- Verschueren, N. et al. (2005). Everyday conditional reasoning: A working memory-dependent tradeoff between counterexample and likelihood use. *Mem. Cognit*. 33, 107-119.

Further reading

- Georges-Henri Luquet (2001). *Children's Drawings*. Free Association Books. ISBN 1-85343-516-3
- Groesser, S.N. (2012). *Mental model of dynamic systems*. In N.M. Seel (Ed.). The encyclopedia of the sciences of learning (Vol. 5, pp. 2195–2200). New York: Springer.
- Groesser, S.N. & Schaffernicht, M. (2012). *Mental Models of Dynamic Systems: Taking Stock and Looking Ahead*. System Dynamics Review, 28(1): 46-68, Wiley.
- Johnson-Laird, P.N. 2005. The History of Mental Models
- Johnson-Laird, P.N., 2005. Mental Models, Deductive Reasoning, and the Brain
- Jones, N. A. et al. (2011). "Mental Models: an interdisciplinary synthesis of theory and methods" *Ecology and Society*.16 (1): 46.
- Jones, N. A. et al. (2014). "Eliciting mental models: a comparison of interview procedures in the context of natural resource management" *Ecology and Society*.19 (1): 13.
- Prediger, S. (2008). "Discontinuities for mental models - a source for difficulties with the multiplication of fractions" *Proceedings of ICME-11, Topic Study Group 10, Research and Development of Number Systems and Arithmetic*. (See also Prediger's references to Fischbein 1985 and Fischbein 1989, "Tacit models and mathematical reasoning".)
- Robles-De-La-Torre, G. & Sekuler, R. (2004). "Numerically Estimating Internal Models of Dynamic Virtual Objects". In: *ACM Transactions on Applied Perception 1(2)*, pp. 102–117.
- Sterman, John D. A Skeptic's Guide to Computer Models, Massachusetts Institute of Technology

TOC Previous

External links

- Mental Models and Reasoning Laboratory
- Systems Analysis, Modelling and Prediction Group, University of Oxford
- System Dynamics Society

Categories:

- Conceptual models
- Cognitive modeling
- Cognitive psychology
- Cognitive science
- Information
- Information science
- Scientific modeling

This page was last edited on 9 June 2018, at 04:09.

Contents

Social Cognition

Jump to navigation Jump to search
For the academic journal, see Social Cognition (journal).

Social cognition is "a sub-topic of social psychology that focuses on how people process, store, and apply information about other people and social situations. It focuses on the role that cognitive processes play in social interactions."[1]

More technically, social cognition refers to how people deal with conspecifics (members of the same species) or even across species (such as pet) information, include four stages: encoding, storage, retrieval, and processing. In the area of social psychology, social cognition refers to a specific approach in which these processes are studied according to the methods of cognitive psychology and information processing theory. According to this view, social cognition is a level of analysis that aims to understand social psychological phenomena by investigating the cognitive processes that underlie them.[2] The major concerns of the approach are the processes involved in the perception, judgment, and memory of social stimuli; the effects of social and affective factors on information processing; and the behavioral and interpersonal consequences of cognitive processes. This level of analysis may be applied to any content area within social psychology, including research on intrapersonal, interpersonal, intragroup, and intergroup processes.

The term *social cognition* has been used in multiple areas in psychology and cognitive neuroscience, most often to refer to various social abilities disrupted in autism,[3] schizophrenia[4] and other disorders.[5] In cognitive neuroscience the biological basis of social cognition is investigated.[6][7][8] Developmental psychologists study the development of social cognition abilities.[9]

TOP

Historical development

Social cognition came to prominence with the rise of cognitive psychology in the late 1960s and early 1970s and is now the dominant model and approach in mainstream social psychology.[10] Common to social cognition theories is the idea that information is represented in the brain as "cognitive elements" such as schemas, attributions, or stereotypes. A focus on how these cognitive elements are processed is often employed. Social cognition therefore applies and extends many themes, theories, and paradigms from cognitive psychology that can be identified in reasoning (representativeness heuristic, base rate fallacy and confirmation bias), attention (automaticity and priming) and memory (schemas, primacy and recency). It is likely that social psychology has always had a more cognitive than general psychology approach, as it traditionally discussed internal mental states such as beliefs and desires when mainstream psychology was dominated by behaviorism.[11]

One notable theory of social cognition is social schema theory, although it is not the basis of all social cognition studies (for example, see attribution theory).[11] It has been suggested that other disciplines in social psychology such as social identity theory and social representations may be seeking to explain largely the same phenomena as social cognition, and that these different disciplines might be merged into a "coherent integrated whole".[12] A parallel paradigm has arisen in the study of action, termed motor cognition, which is concerned with understanding the representation of action and the associated process.

Social schemas

Social schema theory builds on and uses terminology from schema theory in cognitive psychology, which describes how ideas or " concepts" are represented in the brain and how they are categorized. According to this view, when we see or think of a concept a mental representation or schema is "activated" bringing to mind other information which is linked to the original concept by association. This activation often happens unconsciously. As a result of activating such schemas, judgements are formed which go beyond the information actually available, since many of the associations the schema evokes extend outside the given information. This may influence social cognition and behaviour regardless of whether these judgements are accurate or not. For example, if an individual is introduced as a teacher, then a "teacher schema" may be activated. Subsequently, we might associate this person with wisdom or authority, or past experiences of teachers that we remember and consider important.

When a schema is more accessible it can be more quickly activated and used in a particular situation. Two cognitive processes that increase accessibility of schemas are salience and priming. Salience is the degree to which a particular social object stands out relative to other social objects in a situation. The higher the salience of an object the more likely that schemas for that object will be made accessible. For example, if there is one female in a group of seven males, female gender schemas may be more accessible and influence the group's thinking and behavior toward the female group member.[11] Priming refers to any experience immediately prior to a situation that causes a schema to be more accessible. For example, watching a scary movie late at night might increase the accessibility of frightening schemas, increasing the likelihood that a person will perceive shadows and background noises as potential threats.

Social cognition researchers are interested in how new information is integrated into pre-established schemas, especially when the information contrasts with the existing schema.[13] For example, a student may have a pre-established schema that all teachers are assertive and bossy. After

encountering a teacher who is timid and shy, a social cognition researcher might be interested in how the student will integrate this new information with his/her existing teacher schema. Pre-established schemas tend to guide attention to new information, as people selectively attend to information that is consistent with the schema and ignore information that is inconsistent. This is referred to as a confirmation bias. Sometimes inconsistent information is sub-categorized and stored away as a special case, leaving the original schema intact without any alterations. This is referred to as subtyping.

Social cognition researchers are also interested in the regulation of activated schemas. It is believed that the situational activation of schemas is automatic, meaning that it is outside individual conscious control.[citation needed] In many situations however, the schematic information that has been activated may be in conflict with the social norms of the situation in which case an individual is motivated to inhibit the influence of the schematic information on their thinking and social behavior.[citation needed] Whether a person will successfully regulate the application of the activated schemas is dependent on individual differences in self-regulatory ability and the presence of situational impairments to executive control.[citation needed] High self-regulatory ability and the lack of situational impairments on executive functioning increase the likelihood that individuals will successfully inhibit the influence of automatically activated schemas on their thinking and social behavior.[citation needed] When people stop suppressing the influence of the unwanted thoughts, a rebound effect can occur where the thought becomes hyper-accessible.[citation needed]

Cultural differences

Social psychologists have become increasingly interested in the influence of culture on social cognition.[14] Although people of all cultures use schemas to understand the world, the content of schemas has been found to differ for individuals based on their cultural upbringing. For example, one study interviewed a Scottish settler and a Bantu herdsman from Swaziland and compared their schemas about cattle.[15] Because cattle are essential to the lifestyle of the Bantu people, the Bantu herdsmen's schemas for cattle were far more extensive than the schemas of the Scottish settler. The Bantu herdsmen was able to distinguish his cattle from dozens of others, while the Scottish settler was not.

Cultural influences have been found to shape some of the basic ways in which people automatically perceive and think about their environment.[14] For example, a number of studies have found that people who grow up in East Asian cultures such as China and Japan tend to develop holistic thinking styles, whereas people brought up in Western cultures like Australia and the USA tend to develop analytic thinking styles.[16][17] The typically Eastern holistic thinking style is a type of thinking in which people focus on the overall context and the ways in which objects relate to each other.[16] For example, if an Easterner was asked to judge how a classmate is feeling then he/she might scan everyone's face in the class, and then use this information to judge how the individual is feeling.[18] On the other hand, the typically Western analytic thinking style is a type of thinking style in which people focus on individual objects and neglect to consider the surrounding context.[17] For example, if a Westerner was asked to judge how a classmate is feeling, then he or she might focus only on the classmate's face in order to make the judgment.[18]

Nisbett (2003) suggested that cultural differences in social cognition may stem from the various philosophical traditions of the East (i.e. Confucianism and Buddhism) versus the Greek philosophical traditions (i.e. of Aristotle and Plato) of the West.[14] However, recent research indicates that differences in social cognition may originate from

physical differences in the environments of the two cultures. One study found that scenes from Japanese cities were 'busier' than those in the USA as they contain more objects which compete for attention. In this study, the Eastern holistic thinking style (and focus on the overall context) was attributed to the busier nature of the Japanese physical environment.[19]

Social cognitive neuroscience

Early interest in the relationship between brain function and social cognition includes the case of Phineas Gage, whose behaviour was reported to have changed after an accident damaged one or both of his frontal lobes. More recent neuropsychological studies have shown that brain injuries disrupt social cognitive processes. For example, damage to the frontal lobes can affect emotional responses to social stimuli[20][21][22] and performance on theory of mind tasks.[23][24] In the temporal lobe, damage to the fusiform gyrus can lead to the inability to recognize faces.

People with psychological disorders such as autism,[3][25] psychosis,[4][26] mood disorder,[27] Williams syndrome, antisocial personality disorder,[5] Fragile X and Turner's syndrome[28] show differences in social behavior compared to their unaffected peers. Parents with posttraumatic stress disorder (PTSD) show disturbances in at least one aspect of social cognition: namely, joint attention with their young children only after a laboratory-induced relational stressor as compared to healthy parents without PTSD.[29] However, whether social cognition is underpinned by domain-specific neural mechanisms is still an open issue.[30] There is now an expanding research field examining how such conditions may bias cognitive processes involved in social interaction, or conversely, how such biases may lead to the symptoms associated with the condition.

The development of social cognitive processes in infants and children has also been researched extensively (see developmental psychology). For example, it has been suggested that some aspects of psychological processes that promote social behavior (such as facial recognition) may be innate. Consistent with this, very young babies recognize and selectively respond to social stimuli such as the voice, face and scent of their mother.[31]

See also

- Behavioral sink
- Cognitive dissonance
- Distributed cognition
- Empathy
- Joint attention
- Neurodevelopmental framework for learning
- Observational learning
- Online participation
- Paranoid social cognition
- Situated cognition
- Social cognitive theory
- social cognitive theory of morality
- Social emotion
- Social intelligence
- Social neuroscience

References

1. ^ *Park, Mina; Song, Jae-Jin; Oh, Seo Jin; Shin, Min-Sup; Lee, Jun Ho; Oh, Seung Ha (2015). "The Relation between Nonverbal IQ and Postoperative CI Outcomes in Cochlear Implant Users: Preliminary Result". BioMed Research International.* ***2015****: 1–7. doi:10.1155/2015/313274. ISSN 2314-6133.*
2. ^ (International Social Cognition Network: http://www.socialcognition.info)
3. ^ a b *Striano, T.; Reid, V. (eds.). Social Cognition: Development, Neuroscience and Autism. Wiley-Blackwell. ISBN 1-4051-6217-1.*
4. ^ a b *Billeke, P.; Aboitiz, F. (February 2013). "Social cognition in schizophrenia: from social stimuli processing to social engagement". Frontiers in Psychiatry.* ***4*** *(4): eCollection 2013. doi:10.3389/fpsyt.2013.00004. PMC 3580762 . PMID 23444313.*
5. ^ a b *Blair, J.; Mitchel, D.; Blair, K. (2005). Psychopathy, emotion and the brain. Wiley-Blackwell. pp. 25–7. ISBN 0-631-23336-9.*
6. ^ *Cacioppo, J.T.; Berntson, G.G.; Sheridan, J.F. & McClintock, M.K. (2000). "Multilevel integrative analyses of human behavior: social neuroscience and the complementing nature of social and biological approaches" (PDF). Psychological Bulletin.* ***126*** *(6): 829–43. doi:10.1037/0033-2909.126.6.829. PMID 11107878. Archived from the original (PDF) on 2015-08-06.*
7. ^ *Cacioppo, J.T. (2002). "Social neuroscience: understanding the pieces fosters understanding the whole and vice versa". American Psychologist.* ***57*** *(11): 819–31. doi:10.1037/0003-066X.57.11.819. PMID 12564179.*
8. ^ *Adolphs, R. (1999). "Social cognition and the human brain". Trends in Cognitive Sciences.* ***3*** *(12): 469–79. doi:10.1016/S1364-6613(99)01399-6. PMID 10562726.*
9. ^ *Shaffer, D.R.; Kipp, K. (2009). "Chapter 12: Theories of social and cognitive development". Developmental Psychology: Childhood and Adolescence. Wadsworth Publishing Company. ISBN 0-495-60171-3.*
10. ^ *Husain, A. (2012). "Chapter 5: Social Perception and Cognition". Social Psychology. Pearson Education India. ISBN 9788131760000.*

11. ^ [a] [b] [c] *Fiske, S.T.; Taylor, S.E. (1991). Social Cognition. McGraw-Hill, Inc. ISBN 0-07-100910-8.*
12. ^ *Augustinos, M.; Walker, I.; Donaghue, N. (2006). Social Cognition an Integrated Introduction. London: Sage Publications Ltd. ISBN 0-7619-4218-1.*
13. ^ *Alpay, L.; Verhoef, J.; Teeni, D.; Putter, H.; Toussaint, P.; Zwetsloot-Schonk, J. (2008). "Can contextualisation increase understanding during man-machine communication? A theory driven study". The Open Medical Informatics Journal.* ***2****: 82–91. doi:10.2174/1874431100802010082. PMC 2669642 . PMID 19415137.*
14. ^ [a] [b] [c] *Aronson, E.; Wilson, T; Akert, R. (2010). "Chapter 3: Social Cognition". Social Psychology. Pearson.*
15. ^ *Bartlett, F. (1932). Remembering. Cambridge: Cambridge University Press. p. 249.*
16. ^ [a] [b] *Nisbett, R.; Peng, K.; Choi, I.; Norenzayan, A. (2001). "Culture and Systems of thought: Holistic vs. analytic cognition". Psychological Review.* ***108*** *(2): 291–310. doi:10.1037/0033-295X.108.2.291. PMID 11381831.*
17. ^ [a] [b] *Masuda, T.; Nisbett, R. (2006). "Culture and change blindness". Cognitive science: A multidisciplinary journal.* ***30*** *(2): 381–389. doi:10.1207/s15516709cog0000_63.*
18. ^ [a] [b] *Masuda, T.; Ellsworth, P. C.; Mesquita, B. (2008). "Placing the face in context: Cultural differences in the perception of facial emotion". Journal of Personality and Social Psychology.* ***94*** *(3): 365–381. doi:10.1037/0022-3514.94.3.365. PMID 18284287.*
19. ^ *Miyamoto, Y.; Kitayama, S. (2002). "Cultural variation in correspondence bias: The critical role of attitude diagnosticity of socially constrained behaviour". Journal of Personality and Social Psychology.* ***83*** *(5): 1239–1248. doi:10.1037/0022-3514.83.5.1239. PMID 12416925.*
20. ^ *Harmon-Jones, E.; Winkielman, P. (2007). Social Neuroscience: Integrating Biological and Psychological Explanations of Social Behavior. Guilford Press. ISBN 978-1-59385-404-1.*
21. ^ *Damasio, A.R. (1994). Descarte's Error: Emotion, reason and the human brain. New York: Picador. ISBN 0-333-65656-3.*
22. ^ *Hornak, J.; Rolls, E.T.; Wade, D. (1996). "Face and voice*

expression identification in patients with emotional and behavioral changes following ventral frontal lobe damage". Neuropsychologia. ***34*** *(4): 247–61. doi:10.1016/0028-3932(95)00106-9. PMID 8657356.*
23. ^ *Stone, V.E.; Baron-Cohen, S.; Knight, R.T. (1998). "Frontal lobe contributions to theory of mind". Journal of Cognitive Neuroscience.* ***10*** *(5): 640–56. doi:10.1162/089892998562942. PMID 9802997.*
24. ^ *Brunet, E.; Sarfati, Y.; Hardy-Bayle, MC.; Decety, J. (2000). "A PET investigation of attribution of intentions to others with a non-verbal task". NeuroImage.* ***11*** *(2): 157–66. doi:10.1006/nimg.1999.0525. PMID 10679187.*
25. ^ Subbaraju V, Sundaram S, Narasimhan S. Identification of lateralized compensatory neural activities within the social brain due to autism spectrum disorder in adolescent males. *European Journal of Neuroscience*. 2017.
26. ^ *Fusar-Poli, P.; Deste, G.; Smieskova, R.; Barlati, S.; Yung, AR.; Howes, O.; Stieglitz, RD.; Vita, A.; McGuire, P.; Borgwardt, Stefan (Jun 2012). "Cognitive functioning in prodromal psychosis: a meta-analysis". Arch Gen Psychiatry.* ***69*** *(6): 562–71. doi:10.1001/archgenpsychiatry.2011.1592. PMID 22664547.*
27. ^ *Billeke, P.; Boardman, S.; Doraiswamy, P. (December 2013). "Social cognition in major depressive disorder: A new paradigm?". Translational Neuroscience.* ***4*** *(4): 437–447. doi:10.2478/s13380-013-0147-9.*
28. ^ *Mazzocco, M.M.M.; Baumgardner, Thomas; Freund, Lisa S.; Reiss, Allan L.; et al. (1998). "Social Functioning Among Girls with Fragile X or Turner Syndrome and Their Sisters". Journal of Autism and Developmental Disorders.* ***28*** *(6): 509–17. doi:10.1023/A:1026000111467. PMID 9932237.*
29. ^ *Schechter, D.S.; Willheim, E.; Hinojosa, C.; Scholfield-Kleinman, K.; Turner, J.B.; McCaw, J.; Zeanah, C.H.; Myers, M.M. (2010). "Subjective and objective measures of parent-child relationship dysfunction, child separation distress, and joint attention". Psychiatry: Interpersonal and Biological Processes.* ***73*** *(2): 130–44. doi:10.1521/psyc.2010.73.2.130. PMID 20557225.*
30. ^ *Stone, V.E.; Gerrans, P. (2006). "What's domain-specific about theory of mind". Social Neuroscience.* ***1*** *(3–4): 309–19. doi:10.1080/17470910601029221. PMID 18633796.*

31. ^ *Bremner, J.G. (1994). "Chapter 5: Social Development". Infancy. pp. 182–3. ISBN 0-631-14809-4..*

Further reading

- Fiske, S.T. (2004). *Social beings: A core motives approach to social psychology*. New York: Wiley.
- Fiske, S.T. & Taylor, S.E. (2008). *Social Cognition: From Brains to Culture*. New York: McGraw-Hill.
- Malle, B. (2004). *How the mind explains behavior: Folk explanations, meaning, and social interaction*. Cambridge, MA: MIT Press.
- Malle, B. & Hodges, S.D. (2005). *Other Minds: How Humans Bridge the Divide Between Self and Others*. New York: Guilford Press.
- Valsiner, J., Social organization of cognitive development, Internalization and externalization of constraint systems, In Demetriou, *et al.*, (1992, eds.), *Neo-Piagetian Theories of Cognitive Development*. New York, Routledge.
- Marilynn B. Brewer, Miles Hewstone. 2004. Social Cognition: Perspectives on Social Psychology. Publisher John Wiley & Sons, 2004. ISBN 1405110708, 9781405110709
- Ngaire Donaghue, Iain Walker, Martha Augoustinos. 2006. Social Cognition: An Integrated Introduction. Publisher -Pine Forge Press. ISBN 0761942181, 9780761942184
- Ziva Kunda. 1999. Social Cognition: Making Sense of People. Publisher MIT Press. ISBN 0262611430, 9780262611435
- Dona Pennington. 2000. Social Cognition;Routledge Modular Psychology. Publisher-Routledge. ISBN 0415217059, 9780415217057
- Herbert Bless. 2004. Social Cognition: How Individuals Construct Reality:Social Psychology. Publisher-Psychology Press. ISBN 0863778291, 9780863778292

Categories: Behavioral concepts | Cognitive science | Cognition | Enactive cognition | Social learning theory | Social psychology | Social philosophy

This page was last edited on 28 May 2018, at 15:47.

Contents

Glasser's choice Theory

Jump to navigation Jump to search
This article is about choice theory in psychology and education. For choice theory in economics, see rational choice theory.

The term ***choice theory*** is the work of William Glasser, MD, author of the book so named, and is the culmination of some 50 years of theory and practice in psychology and counselling.

TOP

TOC Next

Characteristics

Choice theory posits behaviours we choose are central to our existence. Our behaviour (choices) are driven by five genetically driven needs, survival, love and belonging, freedom, fun, and power. Survival needs include

- food
- clothing
- shelter
- breathing
- personal safety
- security and sex, having children

and four fundamental psychological needs:

- Belonging/connecting/ love
- Power/significance/competence
- Freedom/autonomy
- Fun/learning

Choice theory suggests the existence of a "Quality World". Glasser's idea of a "Quality World" restates the Jungian idea of archetypes but Glasser never acknowledged this. Nonetheless, Glasser's "Quality World" and what Jung would call healthy archetypes are indistinguishable.

Our "Quality World" images are our role models of an individual's "perfect" world of parents, relations, possessions, beliefs, etc. How each person's "Quality World" is somewhat unusual, even in the same family of origin, is taken for granted.

Starting from birth and continuing throughout our lives, each person places significant role models, significant possessions and significant systems of belief (religion, cultural values, and icons, etc.) into a mostly unconscious framework Glasser called our "Quality World". Glasser mostly ignores the issues of negative role models and stereotypes in choice

theory.

Glasser also posits a "Comparing Place" where we compare-contrast our perception of people, places, and things immediately in front of us against our ideal images (archetypes) of these in our Quality World framework. Our subconscious pushes us towards calibrating—as best we can—our real world experience with our Quality World (archetypes).

Behavior ("Total Behavior" in Glasser's terms) is made up of these four components: acting, thinking, feeling, and physiology. Glasser suggests we have considerable control or choice over the first two of these; yet, little ability to directly choose the latter two as they are more deeply sub- and unconscious. These four components remain closely intertwined, the choices we make in our thinking and acting greatly affect our feeling and physiology.

A big conclusion for Glasser, one he repeats often, is the source of much personal unhappiness is failing or failed relationships with people important to us: spouses, parents, children, friends and colleagues.

The symptoms of unhappiness are widely variable and are often seen as mental illness. Glasser believed that "pleasure" and "happiness" are related but are far from synonymous. Sex, for example, is a "pleasure" but may well be divorced from a "satisfactory relationship" which is a precondition for lasting " happiness" in life. Hence the intense focus on the improvement of relationships in counseling with choice theory—the "new reality therapy". Those familiar with both are likely to prefer choice theory, the more modern formulation.

Choice theory posits most mental illness is, in fact, an expression of unhappiness. Glasser champions how we are able to learn and choose alternate behaviors resulting in greater personal satisfaction. Reality therapy is the choice theory-based counseling process focused on helping clients to learn to make those self-optimizing choices.

The ten axioms

1. The only person whose behavior we can control is our own.
2. All we can give another person is information.
3. All long-lasting psychological problems are relationship problems.
4. The problem relationship is always part of our present life.
5. What happened in the past has everything to do with what we are today, but we can only satisfy our basic needs right now and plan to continue satisfying them in the future.
6. We can only satisfy our needs by satisfying the pictures in our Quality World.
7. All we do is behave.
8. All behavior is Total Behavior and is made up of four components: acting, thinking, feeling and physiology
9. All Total Behavior is chosen, but we only have direct control over the acting and thinking components. We can only control our feeling and physiology indirectly through how we choose to act and think.
10. All Total Behavior is designated by verbs and named by the part that is the most recognizable.[1]

TOC Previous Next

In classroom management

William Glasser's choice theory begins: behavior is not separate from choice; we all choose how to behave at any time. Second, we cannot control anyone's behavior but our own. Glasser also believed in the vitality of classroom meetings for the purpose of improving communication and solving real classroom problems. In the classroom, it is important for teachers to "help students envision a quality existence in school and plan the choices that lead to it".[2]

For example, Johnny Waits is an 18-year-old high school senior and plans on attending college to become a computer programmer. Glasser suggests Johnny could be learning as much as he can about computers instead of reading Plato. This concept is called quality curriculum, which connects students with practical real world topics, chosen by the student according to their leanings. Topics with actual career potential are most encouraged. Under Glasser's strategy, teachers hold discussions with students when introducing new topics asking them to identify what they would like to explore in depth. As part of the process, students need to explain why the material is valuable in life.[2]

Education

Glasser was no supporter of Summerhill. Most Quality Schools he supervised had very conventional curriculum topics. The main innovation was a deeper, humanistic approach to group process between teacher, student and learning.

A typical example of choice theory and education are Sudbury Model schools, where students decide for themselves how to spend their days. In these schools, students of all ages determine what they will do, as well as when, how, and where they will do it. This freedom is at the heart of the school and it belongs to the students as their right, not to be violated. The fundamental premises of the school are: that all people are curious by nature; that the most efficient, long-lasting, and profound learning takes place when started and pursued by the learner; that all people are creative if they are allowed to develop their unique talents; that age-mixing among students promotes growth in all members of the group; and that freedom is essential to the development of personal responsibility. In practice this means that students initiate all their own activities and create their own environments. The physical plant, the staff, and the equipment are there for the students to use as the need arises. The school provides a setting in which students are independent, are trusted, and are treated as responsible people; and a community in which students are exposed to the complexities of life in the framework of a participatory democracy.

Sudbury schools are based on the premise that students are personally responsible for their acts, in opposition to virtually all schools today that deny it. The denial is threefold: schools do not permit students to choose their course of action fully; they do not permit students to embark on the course, once chosen; and they do not permit students to suffer the consequences of the course, once taken. Freedom of choice, freedom of action, freedom to bear the results of action—these are the three great freedoms that constitute personal responsibility. Thus, members of these schools learn democracy by experience, and enjoy the rights of individuals.

Sudbury schools do not perform and do not offer evaluations, assessments,

or recommendations, asserting that they do not rate people, and that school is not a judge; comparing students to each other, or to some standard that has been set is for them a violation of the student's right to privacy and to self-determination. Students decide for themselves how to measure their progress as self-starting learners as a process of self-evaluation: real lifelong learning and the proper educational evaluation for the 21st Century, they adduce.

Critiques

Glasser's theories and teachings have not gone without criticism. In a book review,[3] W. Clay Jackson writes, "Dr. Glasser postulates that everything contained in the DSM-IV-TR is a result of an individual's brain creatively expressing its unhappiness. ... Dr. Glasser demonizes the entire profession as charlatans who have been brainwashed by their predecessors or who simply misrepresent many of the psychiatric illnesses to patients as having a biological basis. ... Despite claiming to have an appendix full of references demonstrating there is no evidence medications have a role in curing mental illness, the book simply relies on a core group of anti-establishment authors. ... However, what is noticeably absent from the book is a set of randomized clinical trials demonstrating the success of his teachings."

TOC Previous Next

See also

- Cognitive psychology
- Introspection illusion
- Sudbury Valley School
- Léopold Szondi

TOC Previous Next

References

1. ^ http://www.choicetheory.com
2. ^ [a] [b] Charles, C.M. (2008). *Building Classroom Discipline*. (9th ed.). Boston: Pearson Education.
3. ^ Review of *Warning: Psychiatry Can Be Hazardous to Your Mental Health*, Jackson, W. Clay. 2005. The Primary Care Companion to the Journal of Clinical Psychiatry, Vol. 7, No. 2

- Bourbon, W. Thomas and Ford, Ed. (1994) Discipline at Home and at School. Brandt: New York.
- Personal observations (1996–2005). Teacher. Centennial High School, Champaign, Illinois.
- Weinstein, Jay. (2000). "The Place of Theory in Applied Sociology: A Reflection." *Theory and Science* 1, 1.

External links

- The William Glasser Institute official website
- The Sudbury Valley School official website

Categories:

- Cognitive science

This page was last edited on 20 November 2017, at 03:22.

Back to main TOC

Contents

Cognitive Map

A **cognitive map** (sometimes called a mental map or mental model) is a type of mental representation which serves an individual to acquire, code, store, recall, and decode information about the relative locations and attributes of phenomena in their everyday or metaphorical spatial environment. The concept was introduced by Edward Tolman in 1948.[1] The term was later generalized by some researchers, especially in the field of operations research, to refer to a kind of semantic network representing an individual's personal knowledge or schemas.[2][3][4]

Overview

Cognitive maps have been studied in various fields, such as psychology, education, archaeology, planning, geography, cartography, architecture, landscape architecture, urban planning, management and history. [5][*page needed*] As a consequence, these mental models are often referred to, variously, as cognitive maps, mental maps, scripts, schemata, and frames of reference.

Cognitive maps serve the construction and accumulation of spatial knowledge, allowing the "mind's eye" to visualize images in order to reduce cognitive load, enhance recall and learning of information. This type of spatial thinking can also be used as a metaphor for non-spatial tasks, where people performing non-spatial tasks involving memory and imaging use spatial knowledge to aid in processing the task.[6]

The neural correlates of a cognitive map have been speculated to be the place cell system in the hippocampus[7] and the recently discovered grid cells in the entorhinal cortex.[8]

TOC | Previous | Next

Neurological basis

Cognitive mapping is believed to largely be a function of the hippocampus. The hippocampus is connected to the rest of the brain in such a way that it is ideal for integrating both spatial and nonspatial information. Connections from the postrhinal cortex and the medial entorhinal cortex provide spatial information to the hippocampus. Connections from the perirhinal cortex and lateral entorhinal cortex provide nonspatial information. The integration of this information in the hippocampus makes the hippocampus a practical location for cognitive mapping, which necessarily involves combining information about an object's location and its other features.[9]

O'Keefe and Nadel were the first to outline a relationship between the hippocampus and cognitive mapping.[7] Many additional studies have shown additional evidence that supports this conclusion.[10] Specifically, pyramidal cells (place cells, boundary cells, and grid cells) have been implicated as the neuronal basis for cognitive maps within the hippocampal system.

Numerous studies by O'Keefe have implicated the involvement of place cells. Individual place cells within the hippocampus correspond to separate locations in the environment with the sum of all cells contributing to a single map of an entire environment. The strength of the connections between the cells represents the distances between them in the actual environment. The same cells can be used for constructing several environments, though individual cells' relationships to each other may differ on a map by map basis.[7] The possible involvement of place cells in cognitive mapping has been seen in a number of mammalian species, including rats and macaque monkeys.[10] Additionally, in a study of rats by Manns and Eichenbaum, pyramidal cells from within the hippocampus were also involved in representing object location and object identity, indicating their involvement in the creation of cognitive maps.[9] However, there has been some dispute as to whether such studies of mammalian species indicate the presence of a cognitive map and not another, simpler

method of determining one's environment.[11]

While not located in the hippocampus, grid cells from within the medial entorhinal cortex have also been implicated in the process of path integration, actually playing the role of the path integrator while place cells display the output of the information gained through path integration.[12] The results of path integration are then later used by the hippocampus to generate the cognitive map.[13] The cognitive map likely exists on a circuit involving much more than just the hippocampus, even if it is primarily based there. Other than the medial entorhinal cortex, the presubiculum and parietal cortex have also been implicated in the generation of cognitive maps.[10]

TOC Previous Next

Parallel map theory

There has been some evidence for the idea that the cognitive map is represented in the hippocampus by two separate maps. The first is the bearing map, which represents the environment through self-movement cues and gradient cues. The use of these vector-based cues creates a rough, 2D map of the environment. The second map would be the sketch map that works off of positional cues. The second map integrates specific objects, or landmarks, and their relative locations to create a 2D map of the environment. The cognitive map is thus obtained by the integration of these two separate maps.[13]

TOC Previous Next

Generation

The cognitive map is generated from a number of sources, both from the visual system and elsewhere. Much of the cognitive map is created through self-generated movement cues. Inputs from senses like vision, proprioception, olfaction, and hearing are all used to deduce a person's location within their environment as they move through it. This allows for path integration, the creation of a vector that represents one's position and direction within one's environment, specifically in comparison to an earlier reference point. This resulting vector can be passed along to the hippocampal place cells where it is interpreted to provide more information about the environment and one's location within the context of the cognitive map.[13]

Directional cues and positional landmarks are also used to create the cognitive map. Within directional cues, both explicit cues, like markings on a compass, as well as gradients, like shading or magnetic fields, are used as inputs to create the cognitive map. Directional cues can be used both statically, when a person does not move within his environment while interpreting it, and dynamically, when movement through a gradient is used to provide information about the nature of the surrounding environment. Positional landmarks provide information about the environment by comparing the relative position of specific objects, whereas directional cues give information about the shape of the environment itself. These landmarks are processed by the hippocampus together to provide a graph of the environment through relative locations.[13]

TOC Previous Next

History

The idea of a cognitive map was first developed by Edward C. Tolman. Tolman, one of the early cognitive psychologists, introduced this idea when doing an experiment involving rats and mazes. In Tolman's experiment, a rat was placed in a cross shaped maze and allowed to explore it. After this initial exploration, the rat was placed at one arm of the cross and food was placed at the next arm to the immediate right. The rat was conditioned to this layout and learned to turn right at the intersection in order to get to the food. When placed at different arms of the cross maze however, the rat still went in the correct direction to obtain the food because of the initial cognitive map it had created of the maze. Rather than just deciding to turn right at the intersection no matter what, the rat was able to determine the correct way to the food no matter where in the maze it was placed.[14]

Criticism

In a review, Andrew T.D. Bennett argued that there is no clear evidence for cognitive maps in non-human animals (i.e. cognitive map according to Tolman's definition).[11] This argument is based on analyses of studies where it has been found that simpler explanations can account for experimental results. Bennett highlights three simpler alternatives that cannot be ruled out in tests of cognitive maps in non-human animals "These alternatives are (1) that the apparently novel short-cut is not truly novel; (2) that path integration is being used; and (3) that familiar landmarks are being recognised from a new angle, followed by movement towards them."

TOC | Previous | Next

Related term

A cognitive map is a spatial representation of the outside world that is kept within the mind, until an actual manifestation (usually, a drawing) of this perceived knowledge is generated, a mental map. Cognitive mapping is the implicit, mental mapping the explicit part of the same process. In most cases, a cognitive map exists independently of a mental map, an article covering just cognitive maps would remain limited to theoretical considerations.

In some uses, mental map refers to a practice done by urban theorists by having city dwellers draw a map, from memory, of their city or the place they live. This allows the theorist to get a sense of which parts of the city or dwelling are more substantial or imaginable. This, in turn, lends itself to a decisive idea of how well urban planning has been conducted.

See also

- Cognitive geography
- Fuzzy cognitive map
- Motion perception
- Repertory grid

References

1. ^ *Tolman, Edward C. (July 1948). "Cognitive maps in rats and men". Psychological Review.* ***55*** *(4): 189–208. doi:10.1037/h0061626. PMID 18870876.*
2. ^ *Eden, Colin (July 1988). "Cognitive mapping". European Journal of Operational Research.* ***36*** *(1): 1–13. doi:10.1016/0377-2217(88)90002-1. "In the practical setting of work in with a team of busy managers cognitive mapping is a tool for building interest from all team members in the problem solving activity. [...] The cycle of problem construction, making sense, defining the problem, and declaring a portfolio of solutions, which I have discussed elsewhere (Eden, 1982) is the framework that guides the process of working with teams. Thus building and working with the cognitive maps of each individual is primarily aimed at helping each team member reflectively 'construct' and 'make sense' of the situation they believe the team is facing. (pp. 7–8)"*
3. ^ *Fiol, C. Marlene; Huff, Anne Sigismund (May 1992). "Maps for managers: Where are we? Where do we go from here?". Journal of Management Studies.* ***29*** *(3): 267–285. doi:10.1111/j.1467-6486.1992.tb00665.x. "For geographers, a map is a means of depicting the world so that people understand where they are and where they can go. For cognitive researchers, who often use the idea of a 'map' as an analogy, the basic idea is the same. Cognitive maps are graphic representations that locate people in relation to their information environments. Maps provide a frame of reference for what is known and believed. They highlight some information and fail to include other information, either because it is deemed less important, or because it is not known. (p. 267)"*
4. ^ *Ambrosini, Véronique; Bowman, Cliff (2002). "Mapping successful organizational routines". In Huff, Anne Sigismund; Jenkins, Mark. Mapping strategic knowledge. London; Thousand Oaks, CA: Sage Publications. pp. 19–45. ISBN 0761969497. OCLC 47900801. "We shall not explain here what cognitive maps are about as this has been done extensively elsewhere (Huff, 1990). Let us just say that cognitive maps are the representation of an individual's personal knowledge, of*

an individual's own experience (Weick and Bougon, 1986), and they are ways of representing individuals' views of reality (Eden et al., 1981). There are various types of cognitive maps (Huff, 1990). (pp. 21–22)"

5. ^ *Knight, Peter (2002). Conspiracy nation: the politics of paranoia in Postwar America. New York and London: New York University Press. ISBN 0814747353.*
6. ^ *Kitchin, Robert M. (1994). "Cognitive maps: what are they and why study them?". Journal of Environmental Psychology.* ***14*** *(1): 1–19. doi:10.1016/S0272-4944(05)80194-X.*
7. ^ *a b c O'Keefe, John; Nadel, Lynn (1978). The hippocampus as a cognitive map. Oxford; New York: Clarendon Press; Oxford University Press. ISBN 0198572069. OCLC 4430731.*
8. ^ *Sargolini, Francesca; Fyhn, Marianne; Hafting, Torkel; McNaughton, Bruce L.; Witter, Menno P.; Moser, May-Britt; Moser, Edvard I. (May 2006). "Conjunctive representation of position, direction, and velocity in entorhinal cortex". Science.* ***312*** *(5774): 758–762. Bibcode: 2006Sci...312..758S. doi:10.1126/science.1125572. PMID 16675704.*
9. ^ *a b Manns, Joseph R.; Eichenbaum, Howard (October 2009). "A cognitive map for object memory in the hippocampus". Learning & Memory.* ***16*** *(10): 616–624. doi:10.1101/lm.1484509. PMC 2769165 . PMID 19794187.*
10. ^ *a b c Moser, Edvard I.; Kropff, Emilio; Moser, May-Britt (2008). "Place cells, grid cells, and the brain's spatial representation system". Annual Review of Neuroscience.* ***31****: 69–89. doi:10.1146/annurev.neuro.31.061307.090723. PMID 18284371.*
11. ^ *a b Bennett, Andrew T. D. (January 1996). "Do animals have cognitive maps?". The Journal of Experimental Biology.* ***199*** *(Pt 1): 219–224. PMID 8576693.*
12. ^ *McNaughton, Bruce L.; Battaglia, Francesco P.; Jensen, Ole; Moser, Edvard I.; Moser, May-Britt (August 2006). "Path integration and the neural basis of the 'cognitive map' ". Nature Reviews Neuroscience.* ***7*** *(8): 663–678. doi:10.1038/nrn1932. PMID 16858394.*
13. ^ *a b c d Jacobs, Lucia F.; Schenk, Françoise (April 2003).*

"Unpacking the cognitive map: the parallel map theory of hippocampal function". Psychological Review. ***110*** *(2): 285–315. doi:10.1037/0033-295X.110.2.285. PMID 12747525.*

14. ^ *Goldstein, E. Bruce (2011). Cognitive psychology: connecting mind, research, and everyday experience (3rd ed.). Belmont, CA: Wadsworth Cengage Learning. pp. 11–12. ISBN 9780840033550. OCLC 658234658.*

External links

Categories:

- Cognitive science
- Mnemonics
- Knowledge representation

This page was last edited on 13 April 2018, at 05:21.

Back to main TOC

Contents

Psychological effects of Internet Use

Jump to navigation Jump to search

Various researchers have undertaken efforts to examine the **psychological effects of Internet use**. Some research employs studying brain functions in Internet users. Some studies assert that these changes are harmful, while others argue that asserted changes are beneficial.[1]

TOP

TOC Next

Assertions

American writer Nicholas Carr asserts that Internet use reduces the deep thinking that leads to true creativity. He also says that hyperlinks and overstimulation means that the brain must give most of its attention to short-term decisions. Carr also states that the vast availability of information on the World Wide Web overwhelms the brain and hurts long-term memory. He says that the availability of stimuli leads to a very large cognitive load, which makes it difficult to remember anything.[2][3]

Computer scientist Ramesh Sitaraman has asserted that Internet users are impatient and are likely to get more impatient with time.[7] In a large-scale research study[4][8] that completed in 2012 involving millions of users watching videos on the Internet, Krishnan and Sitaraman show that users start to abandon online videos if they do not start playing within two seconds.[9] In addition, users with faster Internet connections (such as FTTH) showed less patience and abandoned videos at a faster rate than users with slower Internet connections. Many commentators have since argued that these results provide a glimpse into the future: as Internet services become faster and provide more instant gratification, people become less patient[5][6] and less able to delay gratification and work towards longer-term rewards.[10]

Psychologist Steven Pinker, however, argues that people have control over what they do, and that research and reasoning never came naturally to people. He says that "experience does not revamp the basic information-processing capacities of the brain" and asserts that the Internet is actually making people smarter.[11]

MRI studies

The BBC describes the research published in the peer-reviewed science journal *PLoS ONE*:

> "A research team led by Hao Lei of the Chinese Academy of Sciences in Wuhan carried out brain scans of 35 men and women aged between 14 and 21. Seventeen of them were classed as having Internet addiction disorder (IAD) on the basis of answering yes to questions such as, “Have you repeatedly made unsuccessful efforts to control, cut back or stop Internet use?”[12]

Specialised MRI brain scans showed changes in the white matter of the brain—the part that contains nerve fibres—in those classed as being web addicts, compared with non-addicts. Furthermore, the study says, "We provided evidences demonstrating the multiple structural changes of the brain in IAD subjects. VBM results indicated the decreased gray matter volume in the bilateral dorsolateral prefrontal cortex (DLPFC), the supplementary motor area (SMA), the orbitofrontal cortex (OFC), the cerebellum and the left rostral ACC (rACC)." [13]

UCLA professor of psychiatry Gary Small studied brain activity in experienced web surfers versus casual web surfers. He used MRI scans on both groups to evaluate brain activity. The study showed that when Internet surfing, the brain activity of the experienced Internet users was far more extensive than that of the novices, particularly in areas of the prefrontal cortex associated with problem-solving and decision making. However, the two groups had no significant differences in brain activity when reading blocks of text. This evidence suggested that the distinctive neural pathways of experienced Web users had developed because of their Web use. Dr. Small concluded that “The current explosion of digital technology not only is changing the way we live and communicate, but is rapidly and profoundly altering our brains.” [14]

Effect on traditional reading

In an August 2008 article in *The Atlantic* ("Is Google Making Us Stupid?"), Nicholas Carr experientially asserts that using the Internet can lead to lower attention span and make it more difficult to read in the traditional sense (that is, read a book at length without mental interruptions). He says that he and his friends have found it more difficult to concentrate and read whole books, even though they read a great deal when they were younger (that is, when they did not have access to the Internet).[15] This assertion is based on anecdotal evidence, not controlled research.

Researchers from the University College London have done a 5-year study on Internet habits, and have found that people using the sites exhibited “a form of skimming activity,” hopping from one source to another and rarely returning to any source they’d already visited. The 2008 report says, "It is clear that users are not reading online in the traditional sense; indeed there are signs that new forms of “reading” are emerging as users “power browse” horizontally through titles, contents pages and abstracts going for quick wins. It almost seems that they go online to avoid reading in the traditional sense."[16]

TOC Previous Next

Brain power

Research suggests that using the Internet helps boost brain power for middle-aged and older people[17] (research on younger people has not been done). The study compares brain activity when the subjects were reading and when the subjects were surfing the Internet. It found that Internet surfing uses much more brain activity than reading does. Lead researcher Professor Gary Small said: "The study results are encouraging, that emerging computerized technologies may have physiological effects and potential benefits for middle-aged and older adults.[18] Internet searching engages complicated brain activity, which may help exercise and improve brain function."[19]

Productivity

One of the most widely debated effects of social networking has been its influence on productivity. In many schools and workplaces, social media sites are blocked because employers believe their employees will be distracted and unfocused on the sites. It seems, at least from one study, that employers do, indeed, have reason to be concerned. A survey from Hearst Communications found that productivity levels of people that used social networking sites were 1.5% lower than those that did not.[20] Logically, people cannot get work done when they are performing other tasks. If the employees suffer from degrading self-control, it will be even harder for them to get back to work and maintain productivity.

Effects of social networking and behavior

Evgeny Morozov has said that social networking could be potentially harmful to people. He writes that they can destroy privacy, and notes that "Insurance companies have accessed their patients' Facebook accounts to try to disprove they have hard-to-verify health problems like depression; employers have checked social networking sites to vet future employees; university authorities have searched the web for photos of their students' drinking or smoking pot." He also said that the Internet also makes people more complacent and risk averse. He said that because much of the ubiquity of modern technology—cameras, recorders, and such—people may not want to act in unusual ways for fear of getting a bad name. People can see pictures and videos of you on the Internet, and this may make you act differently.[21]

Attention span

According to the New York Times, many scientists say that "people's ability to focus is being undermined by bursts of information".[22]

From 53,573 page views taken from various users, 17% of the views lasted less than 4 seconds while 4% lasted more than 10 minutes. In regards to page content, users will only read 49% of a site that contains 111 words or fewer while users will opt to read 28% of an average website (approximately 593 words). For each additional 100 words on a site, users will spend 4.4 seconds longer on the site.[23]

It is found that those who read articles online go through the article more thoroughly than those who read from print-based materials. Upon choosing their reading material, online readers read 77% of the content, which can be compared to broadsheet newspaper where the corresponding number is 62%.[24]

TOC Previous Next

Effects of anonymity

See also: Internet anonymity and Anonymous post

Interacting on the Internet mostly does not involve "physical" interactions with another person (i.e. face-to-face conversation), and therefore easily leads to a person feeling free to act differently online, as well as unrestraint in civility and minimization of authority, etc.

People who are socially anxious are more likely to use electronic communication as their only means of communication. This, in turn, makes them more likely to disclose personal information to strangers online that they normally wouldn't give out face-to-face.[25] The phenomenon is a likely cause for the prevalence of cyberbullying, especially for children who do not understand "social networking etiquette."

Internet anonymity can lead to online disinhibition, in which people do and say things online that they normally wouldn't do or say in person. Psychology researcher John Suler differentiates between *benign disinhibition* in which people can grow psychologically by revealing secret emotions, fears, and wishes and showing unusual acts of kindness and generosity and *toxic disinhibition*, in which people use rude language, harsh criticisms, anger, hatred and threats or visit pornographic or violent sites that they wouldn't in the 'real world.' [26]

TOC Previous Next

Internet addiction

Main article: Internet addiction disorder

People become addicted or dependent on the Internet through excessive computer use that interferes with daily life. Kimberly S. Young [27] links internet addiction disorder with existing mental health issues, most commonly depression. Young states that the disorder has significant effects socially, psychologically and occupationally.

"Aric Sigman’s presentation to members of the Royal College of Paediatrics and Child Health outlined the parallels between screen dependency and alcohol and drug addiction: the instant stimulation provided by all those flickering graphics leads to the release of dopamine, a chemical that’s central to the brain’s reward system".[28]

A 2009 study suggested that brain structural changes were present in those classified by the researchers as Internet addicted, similar to those classified as chemically addicted.[29]

In one study, the researchers selected seventeen subjects with online gaming addiction and another seventeen naive internet users who rarely used the internet. Using a magnetic resonance imaging scanner, they performed a scan to "acquire 3-dimensional T1-weighted images" of the subject's brain. The results of the scan revealed that online gaming addiction "impairs gray and white matter integrity in the orbitofrontal cortex of the prefrontal regions of the brain".[30] According to Keath Low, psychotherapist, the orbitofrontal cortex "has a major impact on our ability to perform such tasks as planning, prioritizing, paying attention to and remembering details, and controlling our mention".[31] As a result, these online gaming addicts are incapable of prioritizing their life or setting a goal and accomplishing it because of the impairment of their orbitofrontal cortex.

Escapism

Main article: Escapism

Ease of access to the Internet can increase escapism in which a user uses the Internet as an "escape" from the perceived unpleasant or banal aspects of daily/real life. Because the internet and virtual realities easily satisfy social needs and drives, according to Jim Blascovich and Jeremy Bailensen, "sometimes [they are] so satisfying that addicted users will withdraw physically from society.” Stanford psychiatrist Dr. Elias Aboujaoude believes that advances in virtual reality and immersive 3-D have led us to “where we can have a ‘full life’ [online] that can be quite removed from our own.” Eventually, virtual reality may drastically change a person’s social and emotional needs. “We may stop ‘needing’ or craving real social interactions because they may become foreign to us,” Aboujaoude says.[32]

TOC Previous Next

Effects on children

Internet has its impact on all age groups from elders to children. According to the article 'Digital power: exploring the effects of social media on children's spirituality', children consider the Internet as their third place after home and school.[33]

One of the main effects social media has had on children is the effect of cyber bullying. A study carried out by 177 students in Canada found that "15% of the students admitted that they cyberbullied others" while "40% of the cyber victims had no idea who the bullies were".[34] The psychological harm cyber bullying can cause is reflected in low self-esteem, depression and anxiety. It also opens up avenues for manipulation and control. Cyber bullying has ultimately led to depression, anxiety and in severe cases suicide. Suicide is the third leading cause of death for youth between the ages of 10 and 24. Cyber bullying is rapidly increasing. Some writers have suggested monitoring and educating children from a young age about the risks associated with cyber bullying. {{Cite: Adams Richar,2015, 'Fewer school bullies but cyberbullying is on the increase'}} Not only does cyberbullying effect children but a huge issue is insomnia. This is because of the amount of time spent using the internet. children use on average 27 hours of internet a week and it is on the increase. {{ cite: Jerald J. Block, M.D.2008 "Issues for DSM-V: Internet Addiction." American Journal of Psychiatry, 165(3), pp. 306–307}}

Effects on parenting

"A psychologist, Aric Sigman, warned of the perils of “passive parenting” and “benign neglect” caused by parent's reliance on gadgets".[28] In some cases, parents' internet addictions can have drastic effects on their children. In 2009, a three-year-old girl from New Mexico died of malnutrition and dehydration on the same day that her mother was said to have spent 15 hours playing World of Warcraft online.[32] In another case in 2014, a Korean couple became so immersed in a video game that allowed them to raise a virtual child online that they let their real baby die.[35] The effects of the Internet on parenting can be observed a how parents utilize the Internet, the response to their child's Internet consumption, as well as the effects and influences that the Internet has on the relationship between parent and child.

TOC Previous Next

Parental Internet use and opinions towards family impact

Overall, parents are seen to do simple tasks such as sending e-mails and keep up with current events whereas social networking sites are less frequented. In regards to researching parental material, a study conducted in January 2012 by the University of Minnesota found that 75% of questioned parents have stated that the Internet improves their method of obtaining parenting related information, 19.7% found parenting websites too complex to navigate, and 13.1% of the group did not find any useful parenting information on any website.[36]

Many studies have shown that parents view the Internet as a hub of information especially in their children's education.[37] They feel that it is a valuable commodity that can enhance their learning experience and when used in this manner it does not contribute to any family tension or conflicts. However, when the Internet is used as a social medium (either online gaming or social networking sites) there is a positive correlation between the use of the Internet and family conflicts. In conjunction with using the Internet for social means, there is a risk of exposing familial

information to strangers, which is perceived to parents as a threat and can ultimately weaken family boundaries.

Parental response to child online consumption

A report released in October 2012 by Ofcom focused on the amount of online consumption done by children aged 5–15 and how the parents react to their child's consumption. Of the parents interviewed, 85% use a form of online mediation ranging from face-to-face talks with their children about online surfing to cellphone browser filters. The remaining 15% of parents do not take active measures to adequately inform their children of safe Internet browsing; these parents have either spoken only briefly to their children about cautious surfing or do not do anything at all.

Parents are active in monitoring their child's online use by using methods such as investigating the browsing history and by regulating Internet usage. However, since parents are less versed in Internet usage than their children they are more concerned with the Internet interfering with family life than online matters such as child grooming or cyber-bullying.

When addressing those with lack of parental control over the Internet, parents state that their child is rarely alone (defined for children from 5–11 years old) or that they trust their children when they are online (for children 12–15 years old). Approximately 80% of parents ensure that their child has been taught Internet safety from school and 70% of parents feel that the benefits of using the Internet are greater than the risks that come along with it.[38]

Conversely an American study, conducted by PewInternet released on November 20, 2012, reveal that parents are highly concerned about the problems the Internet can impose on their teenage children. 47% of parents are tend to worry about their children being exposed to inappropriate material on the Internet and 45% of the parents are concerned about their children's behaviour towards each other both online offline. Only 31% of parents showed concern about the Internet taking away social time from the family.[39]

Effects of Internet use on parent-child relationships

Researcher Sanford Grossbart and others explores the relationship between the mother and child and how Internet use affects this relationship. This study forms its basis around Marvin Sussman and Suzanne Steinmetz's idea that the relationship between parent and child is highly influenced by the changing experiences and events of each generation.[40] "Parental warmth" is a factor in how receptive a parent is to being taught the nuances of the Internet by their child versus the traditional method of the parent influencing the child. If the parent displayed "warm" tendencies she was more open to learning how to use the Internet from their child even if the parent happened to be more knowledgeable on the subject. This fosters teaching in a positive environment, which sustains a strong relationship between mother and child, encourages education, and promotes mature behaviour. "Cooler" mothers only allowed themselves to be taught if they thought that their child held the same amount of knowledge or greater and would dismiss the teaching otherwise suggesting a relationship that stems from the majority of influence coming from the parent.[41]

However, despite *warm* and *cool* parenting methods, parents who encounter a language barrier rely more heavily on their children to utilize the Internet. Vikki Katz of Rutgers University has studied the interaction between immigrant parents and children and how they use technology. Katz notes that the majority resources that immigrants find helpful are located online, however the search algorithms currently in place do not direct languages other than English appropriately. Because of this shortcoming, parents strongly encourage their bilingual children to bridge the gap between the Internet and language.[42]

The Internet is increasingly being used as a virtual babysitter when parents actively download applications specifically for their children with intentions to keep them calm. A survey conducted by Ipsos has found that half of the interviewed parents believe children ages 8–13 are old enough to own or carry smartphones thus increasing online content consumption in younger generations.[43]

See also

- Millennials

TOC | Previous | Next

References

1. ^ *"Carr, Pinker, the shallows, and the nature-nurture canard : Neuron Culture". Scienceblogs.com. Retrieved 20 September 2011.*
2. ^ *"Author Nicholas Carr: The Web Shatters Focus, Rewires Brains | Magazine". Wired.com. 2010-05-24. Retrieved 4 July 2010.*
3. ^ *"The effects of the Internet: Fast forward". The Economist. 2010-06-24. Retrieved 4 July 2010.*
4. ^ ***a*** ***b*** *"Video Stream Quality Impacts Viewer Behavior, by Krishnan and Sitaraman, ACM Internet Measurement Conference" (PDF). November 2012.*
5. ^ ***a*** ***b*** *"Patience is a Network Effect, by Nicholas Carr, Nov 2012".*
6. ^ ***a*** ***b*** The Patience Deficit, by Nicholas Carr, Dec 2013.
7. ^ *"NPR Morning Edition: In Video-Streaming Rat Race, Fast is Never Fast Enough, October 2012".*
8. ^ *"Science Daily: How Online Video Stream Quality Affect Viewer Behavior, November 2012".*
9. ^ *"CNN: Online viewers ditch slow-loading video after 2 seconds, November 2012".*
10. ^ *"Boston Globe: Instant gratification is making us perpetually impatient, Feb 2013".*
11. ^ *Pinker, Steven (2010-06-10). "Mind Over Mass Media". The New York Times. Retrieved 4 July 2010.*
12. ^ *Helen Briggs (11 January 2012). "Web addicts have brain changes, research suggests". BBC News. Retrieved 17 March 2013.*
13. ^ *Yuan K, Qin W, Wang G, Zeng F, Zhao L, et al. (3 June 2011). "Microstructure Abnormalities in Adolescents with Internet Addiction Disorder". PLoS ONE.* ***6****: e20708. doi:10.1371/journal.pone.0020708. PMC 3108989 . PMID 21677775. Retrieved 17 March 2013.*
14. ^ *Nicholas Carr (24 May 2010). "The Web Shatters Focus, Rewires Brains". Wired Magazine. Retrieved 20 September 2011.*
15. ^ *Nicholas Carr (1 July 2008). "Is Google Making Us Stupid?". The Atlantic. Retrieved 20 September 2011.*

16. ^ *Rowlands Ian (2008). "The Google generation: the information behaviour of the researcher of the future". Aslib Proceedings.* ***60****: 290–310. doi:10.1108/00012530810887953.*
17. ^ *Chivers, Tom (2009-10-21). "Internet use 'may improve brain function in adults', says UCLA study". The Telegraph UK.*
18. ^ *"Internet Use Increases Brain Activity in Seniors". DailyChump. 2012.*
19. ^ *"Internet use 'good for the brain' ". BBC News. 2008-10-14.*
20. ^ *Jung, Brian. "The Negative Effect of Social Media on Society and Individuals". Chron. Hearst Communications, Inc. Retrieved 8 February 2013.*
21. ^ *"Losing our minds to the web". Prospect Magazine. 2010-06-22. Retrieved 20 September 2011.*
22. ^ *Richtel, Matt (2010-06-06). "Attached to Technology and Paying a Price". The New York Times.*
23. ^ *"Attention Span Statistics". Statistic Brain. The Associated Press. 16 May 2012. Retrieved 10 February 2013.*
24. ^ *Goldsmith, Belinda (31 March 2007). "Web news readers have greater attention span: study". Reuters. Retrieved 10 February 2013.*
25. ^ Cyberbullying: Bullying in the Digital Age
26. ^ *Suler John (2004). "The Online Disinhibition Effect". CyberPsychology & Behavior.* ***7****: 321–326. doi:10.1089/1094931041291295.*
27. ^ *Young K (1998). "The relationship between depression and internet addiction". CyberPsychology & Behavior.* ***1****: 25–28. doi:10.1089/cpb.1998.1.25.*
28. ^ ***a*** ***b*** *Rowan Pelling (22 May 2012). "How technology is taking hold of our children's lives". Telegraph. Retrieved 26 May 2012.*
29. ^ *Zhou Y, et al. (2009). "Gray matter abnormalities in Internet addiction: A voxel-based morphometry study". European Journal of Radiology.* ***79****: 92–95. doi:10.1016/j.ejrad.2009.10.025.*
30. ^ *Weng, Chuan-Bu (2013). "Gray matter and white matter abnormalities in online game addiction". Zhonghua Yi Xue Za Zhi.* ***92****: 3221–3. PMID 23328472.*
31. ^ *Low, Keath. "Executive functions and ADD - ADHD. What are*

executive functions? How do executive functions relate to ADD - ADHD?". *About.com.*
32. ^ *a* *b* Monica Kim, "The Good and the Bad of Escaping to Virtual Reality", *The Atlantic*, February 20, 2015
33. ^ *Yust Karen-Marie (2014). "Digital power: exploring the effects of social media on children's spirituality". International Journal of Children's Spirituality.* ***19***: *133–143. doi:10.1080/1364436X.2014.924908.*
34. ^ *Li, Q (2010). "cyberbullying in high schools: A Study of student behaviours and beliefs about this new phenomenon". journal of aggression, Maltreatment and trauma: 372–392.*
35. ^ Sean Elder, "Korean Couple Let Baby Die While They Played Video Game", *Newsweek*, August 14, 2014
36. ^ *Jessie Connell (March 2012). "Parents' Use of Technology and the Internet" (PDF). University of Minnesota.*
37. ^ *Mesch, Gustavo (2007). "Family Relations and the Internet: Exploring a Family Boundaries Approach" (PDF). The Journal of Family Communication: 119–138.*
38. ^ *"Children and Parents: Media Use and Attitudes Report" (PDF). Ofcom. 23 October 2012. Retrieved 10 February 2013.*
39. ^ *Mary Madden; Sandra Cortesi; Urs Gasser; Amanda Lenhart; Maeve Duggan (20 November 2012). "Parents, Teens, and Online Privacy". Pew Research Center. Retrieved 10 February 2013.*
40. ^ *Sussman, Marvin; Suzanne Steinmetz (1987). Handbook of Marriage and the Family. New York: Plenum Press.*
41. ^ *Sanford Grossbart; Stephanie McConnell Hughes; Susie Pryor; Amber Yost (2002). "Socialization Aspects of Parents, Children, and the Internet". Advances in Consumer Research.* ***29***: *66–70. Retrieved 10 February 2013.*
42. ^ *Schmidt, Alex (12 October 2011). "Immigrant Parents Rely On Kids For Help Online". NPR. Retrieved 10 February 2013.*
43. ^ *Atagana, Michelle (21 September 2012). "US parents relying on mobile devices to entertain their kids [Survey]". Memeburn. Retrieved 10 February 2013.*

External links

- "50 things that are being killed by the internet", Matthew Moore, *The Telegraph*, 4 September 2009
- "Attached to Technology and Paying a Price", Matt Richtel, *New York Times*, 6 June 2010
- Kraut R, Patterson M, Lundmark V, Kiesler S, Mukopadhyay T, Scherlis W (September 1998). "Internet paradox. A social technology that reduces social involvement and psychological well-being?". *Am Psychol*. **53**: 1017–31. doi: 10.1037/0003-066x.53.9.1017. PMID 9841579.

Categories: Cognitive science | Gerontology | Internet culture | Cyberpsychology | Psychology

This page was last edited on 3 April 2018, at 21:11.

Contents

Theoretical Linguistics

Jump to navigation Jump to search
For the journal, see Theoretical Linguistics (journal).

Theoretical linguistics, or **general linguistics**, is the branch of linguistics which inquires into the nature of language itself and seeks to answer fundamental questions as to what language is; how it works; how universal grammar (UG) as a domain-specific mental organ operates, if it exists at all; what are its unique properties; how does language relate to other cognitive processes, etc. Theoretical linguists are most concerned with constructing models of linguistic knowledge, and ultimately developing a linguistic theory.

The fields that are generally considered the core of theoretical linguistics are phonology, morphology, syntax, and semantics. Although phonetics often guides phonology, it is often excluded from the purview of theoretical linguistics, along with sociolinguistics. Theoretical linguistics also involves the search for an explanation of linguistic universals, that is, properties that all, or many languages have in common.

TOP

TOC Next

Terminology

In the first half of the 20th century, the term "general linguistics" was more common (cf. Ferdinand de Saussure's famous *Course in General Linguistics*), which could be contrasted with "language-particular linguistics" (which is more often called descriptive linguistics). Since the 1960s, the term "theoretical linguistics" has typically been used in more or less the same sense as "general linguistics", even though it also contrasts with applied linguistics, and even though it is often said that language description is inherently theoretical. The usual terminology is thus not entirely clear and consistent.

TOC Previous Next

Major fields

Further information: grammar, formal grammar, and grammar framework

TOC Previous Next

Phonetics

Phonetics is the study of speech sounds with concentration on three main points :

- Articulation : the production of speech sounds in human speech organs.
- Perception : the way human ears respond to speech signals, how the human brain analyses them.
- Acoustic features : physical characteristics of speech sounds such as, loudness, amplitude, frequency etc.

According to this definition, phonetics can also be called linguistic analysis of human speech at the surface level. That is one obvious difference from phonology, which concerns the structure and organisation of speech sounds in natural languages, and furthermore has a theoretical and abstract nature. One example can be made to illustrate this distinction: In English, the suffix -*s* can represent either /s/, /z/, or can be silent (written Ø) depending on context.

TOC Next

Articulatory phonetics

The field of articulatory phonetics is a subfield of phonetics. In studying articulation, phoneticians attempt to document how humans produce speech sounds (vowels and consonants). That is, articulatory phoneticians are interested in how the different structures of the vocal tract, called the articulators (tongue, lips, jaw, palate, teeth etc.), interact to create the specific sounds.

Auditory phonetics

Auditory phonetics is a branch of phonetics concerned with the hearing, acquisition and comprehension of phonetic sounds of words of a language. As articulatory phonetics explores the methods of sound production, auditory phonetics explores the methods of reception—the ear to the brain, and those processes.

Acoustic phonetics

Acoustic phonetics is a subfield of phonetics which deals with acoustic aspects of speech sounds. Acoustic phonetics investigates properties like the mean squared amplitude of a waveform, its duration, its fundamental frequency, or other properties of its frequency spectrum, and the relationship of these properties to other branches of phonetics (e.g. articulatory or auditory phonetics), and to abstract linguistic concepts like phones, phrases, or utterances.

Phonology

Further information: Phonology

Phonology (sometimes called *phonemics* or *phonematics*) is the study of how sounds are used in languages to convey meaning. Phonology includes topics such as stress and intonation.

The basic unit of analysis for phonology is called phoneme. A phoneme is a group of sounds which are not distinguished by the language rules in determining the meaning. In English, for example, [t] and [t^h] are different allophones that represent a single phoneme /t/.

Morphology

Morphology is the study of the internal structure of words. For example, in the sentences *The dog runs* and *The dogs run*, the word forms *runs* and *dogs* have an affix *-s* added, distinguishing them from the base forms *dog* and *run*. Adding this suffix to a nominal stem gives plural forms, adding it to verbal stems restricts the subject to third person singular. Some morphological theories operate with two distinct suffixes *-s*, called allomorphs of the morphemes Plural and Third person singular, respectively. Languages differ with respect to their morphological structure. Along one axis, we may distinguish analytic languages, with few or no affixes or other morphological processes from synthetic languages with many affixes. Along another axis, we may distinguish agglutinative languages, where affixes express one grammatical property each, and are added neatly one after another, from fusional languages, with non-concatenative morphological processes (infixation, umlaut, ablaut, etc.) and/or with less clear-cut affix boundaries.

Syntax

Syntax is the study of language structure and phrasal hierarchies, depicted in parse tree format. It is concerned with the relationship between units at the level of words or morphology. Syntax seeks to exactly delineate all and only those sentences which make up a given language, using native speaker intuition. Syntax seeks to formally describe exactly how structural relations between elements (lexical items/words and operators) in a sentence contribute to its interpretation. Syntax uses principles of formal logic and Set Theory to formalize and accurately represent the hierarchical relationship between elements in a sentence. Abstract syntax trees are often used to illustrate the hierarchical structures that are posited. Thus, in active declarative sentences in English the subject is followed by the main verb which in turn is followed by the object (SVO). This order of elements is crucial to its correct interpretation and it is exactly this which syntacticians try to capture. They argue that

there must be a formal computational component contained within the language faculty of normal speakers of a language and seek to describe it.

Semantics

Semantics is the study of intension, that is, the intrinsic meanings of words and phrases. Much of the work in the field of philosophy of language is concerned with the relation between meanings and the word, and this concern cross-cuts formal semantics in several ways. For example, both philosophers of language and semanticists make use of propositional, predicate and modal logics to express their ideas about word meaning.

See also

- Pragmatics
- Digital infinity
- Generative grammar
- Universal grammar
- Minimalist program
- Psycholinguistics
- Biolinguistics
- Formal language
- Linguistic relativity
- Cognitive science
- Discourse analysis
- Critical discourse analysis
- Computational linguistics

TOC Previous

References

- Ottenheimer, H.J. (2006). The Anthropology of Language: An Introduction to Linguistic Anthropology. Canada: Thomas Wadsworth.

Categories:

- Linguistics
- Cognitive science

This page was last edited on 24 May 2018, at 00:55.

Back to main TOC

Contents

Prototype Theory

Jump to navigation Jump to search

Prototype theory is a mode of graded categorization in cognitive science, where some members of a category are more central than others. For example, when asked to give an example of the concept *furniture*, *chair* is more frequently cited than, say, *stool*. Prototype theory has also been applied in linguistics, as part of the mapping from phonological structure to semantics.

TOP

TOC Next

Overview

As formulated in the 1970s by Eleanor Rosch and others, prototype theory was a radical departure from traditional necessary and sufficient conditions as in Aristotelian logic, which led to set-theoretic approaches of extensional or intensional semantics. Thus instead of a definition based model—e.g. a bird may be defined as elements with the features [+feathers], [+beak] and [+ability to fly]—prototype theory would consider a category like bird as consisting of different elements which have unequal status and, therefore, a *robin* is considered to be **more** prototypical of a *bird* than, say, a *penguin* (which, for instance) can't fly). This leads to a graded notion of categories, which is a central notion in many models of cognitive science and cognitive semantics, e.g. in the work of George Lakoff (*Women, Fire and Dangerous Things*, 1987) or Ronald Langacker (*Foundations of Cognitive Grammar*, vol. 1/2 1987/1991).

TOC Previous Next

Terminology

The term *prototype*, as defined in Eleanor Rosch's study "Natural Categories" (1973), and was initially defined as denoting a stimulus, which takes a salient position in the formation of a category, due to the fact that it is the first stimulus to be associated with that category. Rosch later defined it as the most central member of a category.

TOC Previous Next

Categories

In her 1975 paper, *Cognitive Representation of Semantic Categories* (J Experimental Psychology v. 104:192-233), Eleanor Rosch asked 200 American college students to rate, on a scale of 1 to 7, whether they regarded the following items as a good example of the category *furniture*. This ranged from chair and sofa, ranked number 1, to a love seat (number 10), to a lamp (number 31), all the way to a telephone, ranked number 60.

While one may differ from this list in terms of cultural specifics, the point is that such a graded categorization is likely to be present in all cultures. Further evidence that some members of a category are more privileged than others came from experiments involving:

1. *Response Times*: in which queries involving a prototypical members (e.g. *is a robin a bird*) elicited faster response times than for non-prototypical members.

2. *Priming*: When primed with the higher-level (superordinate) category, subjects were faster in identifying if two words are the same. Thus, after flashing *furniture*, the equivalence of *chair-chair* is detected more rapidly than *stove-stove*.

3. *Exemplars*: When asked to name a few exemplars, the more prototypical items came up more frequently.

Subsequent to Rosch's work, prototype effects have been investigated widely in areas such as colour cognition (Brent Berlin and Paul Kay, 1969), and also for more abstract notions. Subjects may be asked, e.g. "to what degree is this narrative an instance of telling a lie?" [Coleman/Kay:1981]. Similarly work has been done on actions (verbs like look, kill, speak, walk [Pulman:83]), adjectives like "tall" [Dirven/Taylor:88], etc.

Another aspect in which Prototype Theory departs from traditional Aristotelian categorization is that there do not appear to be natural

kind categories (bird, dog) vs. artifacts (toys, vehicles).

A common comparison is the use of prototype or the use of exemplars in category classification. Medin, Altom, and Murphy (1984) found that using a mixture of prototype and exemplar information, participants were more accurately able to judge categories. Participants who were presented with prototype values classified based on similarity to stored prototypes and stored exemplars, whereas participants who only had experience with exemplar only relied on the similarity to stored exemplars. Smith and Minda (2002) looked at the use of prototypes and exemplars in dot-pattern category learning. They found that participants used more prototypes than they used exemplars, with the prototypes being the center of the category, and exemplars surrounding it.

TOC | Previous | Next

Basic level categories

The other notion related to prototypes is that of a *basic level* in cognitive categorization. When asked *What are you sitting on?*, most subjects prefer to say chair rather than a subordinate such as *kitchen chair* or a superordinate such as *furniture*. Basic categories are relatively homogeneous in terms of sensory-motor affordances — a chair is associated with bending of one's knees, a fruit with picking it up and putting it in your mouth, etc. At the subordinate level (e.g. [dentist's chairs], [kitchen chairs] etc.) hardly any significant features can be added to that of the basic level; whereas at the superordinate level, these conceptual similarities are hard to pinpoint. A picture of a chair is easy to draw (or visualize), but drawing furniture would be difficult.

Rosch (1978) defines the basic level as that level that has the highest degree of cue validity. Thus, a category like [animal] may have a prototypical member, but no cognitive visual representation. On the other hand, basic categories in [animal], i.e. [dog], [bird], [fish], are full of informational content and can easily be categorized in terms of Gestalt and semantic features.

Clearly semantic models based on attribute-value pairs fail to identify

privileged levels in the hierarchy. Functionally, it is thought that basic level categories are a decomposition of the world into maximally informative categories. Thus, they

- maximize the number of attributes shared by members of the category, and
- minimize the number of attributes shared with other categories

However, the notion of Basic Level is problematic, e.g. whereas dog as a basic category is a species, bird or fish are at a higher level, etc. Similarly, the notion of frequency is very closely tied to the basic level, but is hard to pinpoint.

More problems arise when the notion of a prototype is applied to lexical categories other than the noun. Verbs, for example, seem to defy a clear prototype: [to run] is hard to split up in more or less central members.

TOC Previous Next

Prototype and category formation and autism

Autism has been shown to affect category and prototype formation. Gastgeb, Dundas, Minshew, and Strauss (2011) found that adults with high-functioning autism had difficulty forming categories and prototypes for dot patterns. Compared to those without autism, the pattern of results was the same, but overall performance of the autism groups was significantly lower.

Individuals with autism have also been shown to have differences in the formation of prototypes for faces. Gatsgeb, Wilkinson, Minshew, and Strauss (2011), in a separate study from the above, found that adults with high-functioning autism have significant difficulty in forming prototypes for faces. After shown a series of faces based on prototypes faces, those with autism had a harder time identifying the prototype faces than those without autism.

Children with autism also show prototype effects. Molesworth, Bowler, and Hampton (2008) found that two-thirds of their sample of autistic

children with high-functioning autism did not show diminished prototype effects, while one-third showed no prototype effects. Molesworth, Bowler, and Hampton (2005) found signs of the prototype effect is children with autism and Asperger syndrome showed signs of prototype effects, yet the effects were not diminished from children without autism or Asperger syndrome.

Distance between concepts

The notion of prototypes is related to Wittgenstein's (later) discomfort with the traditional notion of category. This influential theory has resulted in a view of semantic components more as *possible* rather than necessary contributors to the meaning of texts. His discussion on the category *game* is particularly incisive (Philosophical Investigations 66, 1953):

Clearly, the notion of *family resemblance* is calling for a notion of conceptual distance, which is closely related to the idea of graded sets, but there are problems as well.

Recently, Peter Gärdenfors (2004) has elaborated a possible partial explanation of prototype theory in terms of multi-dimensional feature spaces called conceptual spaces, where a category is defined in terms of a conceptual distance. More central members of a category are "between" the peripheral members. He postulates that most *natural* categories exhibit a convexity in conceptual space, in that if x and y are elements of a category, and if z is *between* x and y, then z is also likely to belong to the category.

However, in the notion of game above, is there a single prototype or several? Recent linguistic data from colour studies seem to indicate that categories may have more than one focal element—e.g. the Tsonga colour term *rihlaza* refers to a green-blue continuum, but appears to have two prototypes, a focal blue, and a focal green. Thus, it is possible to have single categories with multiple, disconnected, prototypes, in which case they may constitute the union of several convex sets rather than a single one.

Combining categories

All around us, we find instances where objects like *tall man* or *small elephant* combine one or more categories. This was a problem for extensional semantics, where the semantics of a word such as *red* is to be defined as the set of objects having this property. Clearly, this does not apply so well to modifiers such as *small*; a *small mouse* is very different from a *small elephant*.

These combinations pose a lesser problem in terms of prototype theory. In situations involving adjectives (e.g. *tall*), one encounters the question of whether or not the prototype of [tall] is a 6 foot tall man, or a 400-foot skyscraper [Dirven and Taylor 1988]. The solution emerges by contextualizing the notion of prototype in terms of the object being modified. This extends even more radically in compounds such as *red wine* or *red hair* which are hardly *red* in the prototypical sense, but the red indicates merely a shift from the prototypical colour of wine or hair respectively. This corresponds to de Saussure's notion of concepts as purely differential: "non pas positivement par leur contenu, mais negativement par leurs rapports avec les autres termes du systeme" [p. 162; not positively, in terms of their content, but negatively by contrast with other terms in the same system (tr. Harris 83)].

Other problems remain—e.g. in determining which of the constituent categories will contribute which feature? In the example of a "pet bird" [Hampton 97], *pet* provides the habitat of the compound (cage rather than the wild), whereas *bird* provides the skin type (feathers rather than fur).

TOC Previous Next

See also

- Exemplar theory
- Family resemblance
- Folksonomy
- Semantic feature-comparison model

Literature

- Berlin, B. & Kay, P. (1969): *Basic Color Terms: Their Universality and Evolution*, Berkeley.
- Dirven, R. & Taylor, J. R. (1988): "The conceptualisation of vertical Space in English: The Case of Tall", in: Rudzka-Ostyn, B.(ed): *Topics in Cognitive Linguistics*. Amsterdam.
- Gatsgeb, H. Z., Dundas, E. M., Minshew, M. J., & Strauss, M. S. (2012). Category formation in autism: Can individuals with autism form categories and prototypes of dot patterns?. Journal of Autism and Development Disorders, 42(8), 1694-1704. doi: 10.1007/s10803-011-1411-x
- Gatsgeb, H. Z., Wilkinson, D. A., Minshew, M. J., & Strauss, M. S. (2011). Can individuals with autism abstract prototypes of natural faces?. Journal of Autism and Development Disorders, 41(12), 1609-1618. doi: 10.1007/s10803-011-1190-4
- *Gärdenfors, P. (2004): Conceptual Spaces: The Geometry of Thought, MIT Press.*
- Lakoff, G. (1987): *Women, fire and dangerous things: What categories reveal about the mind*, London.
- Medin, D. L., Altom, M. W., & Murphy, T. D. (1984). Given versus induced category representations: Use of prototype and exemplar information in classification. Journal of Experimental Psychology: Learning, Memory, and Cognition, 10(3), 333-352. doi: 10.1037/0278-7393.10.3.333
- Molesworth, C. J., Bowler, D. M., & Hamptom, J. A. (2005). Extracting prototypes from exemplars what can corpus data tell us about concept representation?. Journal of Child Psychology and Psychiatry, 46(6), 661-672. doi: 10.1111/j.1469-7610.2004.00383.x
- Molesworth, C. J., Bowler, D. M., & Hamptom, J. A. (2008). When prototypes are not best: Judgments made by children with autism. Journal of Autism and Development Disorders, 38(9), 1721-1730. doi: 10.1007/s10803-008-0557-7
- Loftus, E.F., "Spreading Activation Within Semantic Categories: Comments on Rosch's “Cognitive Representations of Semantic

Categories”", Journal of Experimental Psychology: General, Vol.104, No.3, (September 1975), p.234-240.

- Rosch, E., "Classification of Real-World Objects: Origins and Representations in Cognition", pp. 212–222 in Johnson-Laird, P.N. & Wason, P.C., *Thinking: Readings in Cognitive Science*, Cambridge University Press, (Cambridge), 1977.
- Rosch, E. (1975): “Cognitive Reference Points”, *Cognitive Psychology* 7, 532-547.
- Rosch, E., "Cognitive Representations of Semantic Categories", *Journal of Experimental Psychology: General*, Vol.104, No.3, (September 1975), pp. 192–233.
- Rosch, E.H. (1973): "Natural categories", *Cognitive Psychology* 4, 328-350.
- Rosch, E., "Principles of Categorization", pp. 27–48 in Rosch, E. & Lloyd, B.B. (eds), *Cognition and Categorization*, Lawrence Erlbaum Associates, Publishers, (Hillsdale), 1978.
- Rosch, E., "Prototype Classification and Logical Classification: The Two Systems", pp. 73–86 in Scholnick, E.K. (ed), *New Trends in Conceptual Representation: Challenges to Piaget’s Theory?*, Lawrence Erlbaum Associates, Hillsdale, 1983.
- Rosch, E., "Reclaiming Concepts", *Journal of Consciousness Studies*, Vol.6, Nos.11-12, (November/December 1999), pp. 61–77.
- Rosch, E., "Reply to Loftus", *Journal of Experimental Psychology: General*, Vol.104, No.3, (September 1975), pp. 241–243.
- Rosch, E. & Mervis, C.B., "Family Resemblances: Studies in the Internal Structure of Categories", *Cognitive Psychology*, Vol.7, No.4, (October 1975), pp. 573–605.
- Rosch, E., Mervis, C.B., Gray, W., Johnson, D., & Boyes-Braem, P., *Basic Objects in Natural Categories, Working Paper No.43*, Language Behaviour Research Laboratory, University of California (Berkeley), 1975.
- Rosch, E., Mervis, C.B., Gray, W., Johnson, D., & Boyes-Braem, P., "Basic Objects in Natural Categories", *Cognitive Psychology*, Vol.8, No.3, (July 1976), pp. 382–439.
- Smith, J. D., & Minda, J. P. (2002). Distinguishing prototype-based and exemplar-based processes in dot-pattern category learning.

Journal of Experimental Psychology: Learning, Memory, and Cognition, 28(4), 1433-1458. doi: 10.1037/0278-7393.31.6.1433
- Taylor, J. R.(2003): *Linguistic Categorization*, Oxford University Press.
- Wittgenstein, L., *Philosophical Investigations* *(Philosophische Untersuchungen)*, Blackwell Publishers, 2001 (ISBN 0-631-23127-7).

Categories:

- Cognitive science
- Semantics
- Psychological theories

This page was last edited on 14 June 2018, at 01:27.

Back to main TOC

Contents

Binding Problem

Jump to navigation Jump to search

The **binding problem** is a term used at the interface between neuroscience, cognitive science and philosophy of mind that has multiple meanings.

Firstly, there is the **segregation problem**: a practical computational problem of how brains segregate elements in complex patterns of sensory input so that they are allocated to discrete "objects". In other words, when looking at a blue square and a yellow circle, what neural mechanisms ensure that the square is perceived as blue and the circle as yellow, and not vice versa? The segregation problem is sometimes called BP1.

Secondly, there is the **combination problem**:The problem of how objects, background and abstract or emotional features are combined into a single experience.[1] The combination problem is sometimes called BP2.

However, the difference between these two problems is not always clear. Moreover, the historical literature is often ambiguous as to whether it is addressing the segregation or the combination problem.[1][2]

TOP

TOC Next

The segregation problem

TOC Next

Definition

The segregation problem is the problem of how brains segregate elements in complex patterns of sensory input so that they are allocated to discrete "objects".[2]

Smythies defined BP1 in these terms: "How is the representation of information built up in the neural networks that there is one single object 'out there' and not a mere collection of separate shapes, colours and movements?"[2] Revonsuo refers to this as the problem of "stimulus-related binding" – of sorting stimuli. Although usually referred to as a problem of binding, the computational problem is arguably one of discrimination.[1] Thus, in the words of Canales et al.: "to bind together all the features of one object and segregate them from features of other objects and the background".[3] Bartels and Zeki describe it as "determining that it is the same (or a different) stimulus which is activating different cells in a given visual area or in different visual areas".[4]

TOC Previous Next

Experimental work

Most experimental work is on vision, where it is known that humans and other mammals process different aspects of perception by separating information about those aspects and processing them in distinct regions of the brain. For example, Bartels and Zeki have shown that different areas in the visual cortex specialize in processing the different aspects of colour, motion, and shape. This type of modular coding has been claimed to yield a potential for ambiguity. When humans view a scene containing a blue square and a yellow circle, some neurons signal in response to blue, others signal in response to yellow, still others to a square shape or a circle shape. Here, the binding problem is the issue of how the

brain correctly pairs colour and shape, i.e. indicates that blue goes with square, rather than yellow.[4]

TOC Previous Next

Synchronization theory

A popular hypothesis perhaps first suggested by Milner has been that features of individual objects are bound/segregated via synchronisation of the activity of different neurons in the cortex.[5][6] The theory is that when two feature-neurons fire synchronously they are bound, while when they fire out of synchrony they are unbound. Empirical testing of the idea was given impetus when von der Malsburg proposed that feature binding posed a special problem that could not be covered simply by cellular firing rates.[7] A number of studies suggested that there is indeed a relationship between rhythmic synchronous firing and feature binding. This rhythmic firing appears to be linked to intrinsic oscillations in neuronal somatic potentials, typically in the gamma range close to 40 Hz.[8] However, Thiele and Stoner found that perceptual binding of two moving patterns had no effect on synchronisation of the neurons responding to the two patterns.[9] In the primary visual cortex, Dong et al. found that whether two neurons were responding to contours of the same shape or different shapes had no effect on neural synchrony.[10] Revonsuo reports similar negative findings.[1]

The positive arguments for a role for rhythmic synchrony in resolving the segregational object-feature binding problem (BP1) have been summarized by Singer.[11] There is certainly extensive evidence for synchronization of neural firing as part of responses to visual stimuli. However, there is inconsistency between findings from different laboratories. Moreover, a number of recent reviewers, including Shadlen and Movshon[6] and Merker[12] have raised concerns.

Shadlen and Movshon,[6] raise a series of doubts about both the theoretical and the empirical basis for the idea of segregational binding by temporal synchrony. Firstly, it is not clear that binding does pose a special computational problem of the sort proposed by von der Malsburg.

Secondly, it is unclear how synchrony would come to play a distinct role in terms of local computational logic. Thirdly, it is difficult to envisage a situation in which pre-synaptic firing rate and synchrony could be usefully interpreted independently by a post-synaptic cell, since the two are interdependent over plausible time scales.

Another point that has been raised is that within standard time frames for neuronal firing very few distinct phases of synchrony would be distinguishable even under optimal conditions.[*citation needed*] However, this would only be significant if the same pathways are potentially fed spike (signal) trains in multiple phases. In contrast, Seth[13] describes an artificial brain-based robot that demonstrates multiple, separate, widely distributed neural circuits, firing at different phases, suggesting that synchrony may assist the establishment of discrete object-related re-entrant circuits in a system exposed to randomly timed stimuli.

Goldfarb and Treisman[14] point out that a logical problem appears to arise for binding solely via synchrony if there are several objects that share some of their features and not others. When viewing a display of variously coloured letters, internal representation of a red X, a green O, a red O and a green X cannot be accounted for purely by synchrony of signals for red and X shape, for instance. At best synchrony can facilitate segregation supported by other means (as von der Malsburg acknowledges[15]).

A number of neuropsychological studies suggest that the association of colour, shape and movement as "features of an object" is not simply a matter of linking or "binding". Purves and Lotto[16] give extensive evidence for top-down feedback signals that ensure that sensory data are handled as features of (sometimes wrongly) postulated objects early in processing. In many illusions data appear as if pre-consciously adjusted in accordance with object expectations. Pylyshyn[17] has also emphasized the way the brain seems to pre-conceive objects to which features are to be allocated and which are attributed continuing existence even if features, like color change.

TOC | Previous | Next

Feature integration theory

In her feature integration theory, Treisman suggested that binding between features is mediated by the features' links to a common location. Psychophysical demonstrations of binding failures under conditions of full attention provide support for the idea that binding is accomplished through common location tags.[18]

An implication of these approaches is that sensory data such as colour or motion may not normally exist in "unallocated" form. For Merker:[12] "The 'red' of a red ball does not float disembodied in an abstract color space in V4." If colour information allocated to a point in the visual field is converted directly, via the instantiation of some form of propositional logic (analogous to that used in computer design) into colour information allocated to an "object identity" postulated by a top-down signal as suggested by Purves and Lotto, (e.g. There is blue here + Object 1 is here = Object 1 is blue) no special computational task of "binding together" by means such as synchrony may exist. (Although Von der Malsburg[*citation needed*] poses the problem in terms of binding "propositions" such as "triangle" and "top", these, in isolation, are not propositional.)

How signals in the brain come to have propositional content, or meaning, is a much larger issue. However, both Marr[19] and Barlow[20] suggested, on the basis of what was known about neural connectivity in the 1970s that the final integration of features into a percept would be expected to resemble the way words operate in sentences.

The role of synchrony in segregational binding remains controversial. Merker[12] has recently suggested that synchrony may be a feature of areas of activation in the brain that relates to an "infrastructural" feature of the computational system analogous to increased oxygen demand indicated via MRI. Apparent specific correlations with segregational tasks may be explainable on the basis of interconnectivity of the areas involved. As a possible manifestation of a need to balance excitation and inhibition over time it might be expected to be associated with reciprocal re-entrant circuits as in the model of Seth et al.[13] (Merker gives the analogy of the whistle from an audio amplifier receiving its own output.)

If it transpires that synchronized activity plays at most an infrastructural role in segregative computational "binding", the question arises as to whether we need another explanation. The implication both of Shadlen and Movshon's and of Merker's analyses seems to be that there may be no special binding problem in this sense. The problem may be merely an integral part of the more general problem of the computational logic used by neurons, or what is often referred to as the "neural code". In particular it may be inappropriate to analyse binding in perception without taking into account the way features are bound in memory, as addressed by Zimmer and colleagues,[21] and how that informs the way the brain pre-conceives objects.[*citation needed*]

The combination problem

Definition

Smythies[2] defines BP2 as "How do the brain mechanisms actually construct the phenomenal object?". Revonsuo[1] equates this to "consciousness-related binding", emphasizing the entailment of a phenomenal aspect. As Revonsuo explores in 2006,[22] there are nuances of difference beyond the basic BP1:BP2 division. Smythies speaks of constructing a phenomenal object ("local unity" for Revonsuo) but philosophers such as Descartes, Leibniz, Kant and James (see Brook and Raymont[23]) have typically been concerned with the broader unity of a phenomenal experience ("global unity" for Revonsuo) – which, as Bayne[24] illustrates may involve features as diverse as seeing a book, hearing a tune and feeling an emotion. Further discussion will focus on this more general problem of how sensory data that may have been segregated into, for instance, "blue square" and "yellow circle" are to be re-combined into a single phenomenal experience of a blue square next to a yellow circle, plus all other features of their context. There are a wide range of views on just how real this "unity" is, but the existence of medical conditions in which it appears to be subjectively impaired, or at least restricted, suggests that it is not entirely illusory.[*citation needed*]

History

Early philosophers such as Descartes and Leibniz[*citation needed*] noted that the apparent unity of our experience is an all-or-none qualitative characteristic that does not appear to have an equivalent in the known quantitative features, like proximity or cohesion, of composite matter. William James,[*citation needed*] in the nineteenth century, considered the ways the unity of consciousness might be explained by known physics and found no satisfactory answer. He coined the term "combination problem",

in the specific context of a "mind-dust theory" in which it is proposed that a full human conscious experience is built up from proto- or micro-experiences in the way that matter is built up from atoms. James claimed that such a theory was incoherent, since no causal physical account could be given of how distributed proto-experiences would "combine". He favoured instead a concept of "co-consciousness" in which there is one "experience of A, B and C" rather than combined experiences. A detailed discussion of subsequent philosophical positions is given by Brook and Raymont (see 26). However, these do not generally include physical interpretations. James[*citation needed*] remained concerned about the absence of a "single physical thing", other than an atom, that could be co-conscious (of A, B and C), echoing Leibniz.

Whitehead [25] proposed a fundamental ontological basis for a relation consistent with James's idea of co-consciousness, in which many causal elements are co-available or "compresent" in a single event or "occasion" that constitutes a unified experience. Whitehead did not give physical specifics but the idea of compresence is framed in terms of causal convergence in a local interaction consistent with physics. Where Whitehead goes beyond anything formally recognized in physics is in the "chunking" of causal relations into complex but discrete "occasions". Even if such occasions can be defined, Whitehead's approach still leaves James's difficulty with finding a site, or sites, of causal convergence that would make neurobiological sense for "co-consciousness". Sites of signal convergence do clearly exist throughout the brain but there is a concern to avoid re-inventing what Dennett [26] calls a Cartesian Theater or single central site of convergence of the form that Descartes proposed.

Descartes's central "soul" is now rejected because neural activity closely correlated with conscious perception is widely distributed throughout the cortex. The remaining choices appear to be either separate involvement of multiple distributed causally convergent events or a model that does not tie a phenomenal experience to any specific local physical event but rather to some overall "functional" capacity. Whichever interpretation is taken, as Revonsuo[1] indicates, there is no consensus on what structural level we are dealing with – whether the cellular level, that of cellular groups as "nodes", "complexes" or "assemblies" or that of widely distributed networks. There

is probably only general agreement that it is not the level of the whole brain, since there is evidence that signals in certain primary sensory areas, such as the V1 region of the visual cortex (in addition to motor areas and cerebellum), do not contribute directly to phenomenal experience.

Modern theories

Dennett[26] has proposed that our sense that our experiences are single events is illusory and that, instead, at any one time there are "multiple drafts" of sensory patterns at multiple sites. Each would only cover a fragment of what we think we experience. Arguably, Dennett is claiming that consciousness is not unified and there is no phenomenal binding problem. Most philosophers have difficulty with this position (see Bayne[24]). Dennett's view might be in keeping with evidence from recall experiments and change blindness purporting to show that our experiences are much less rich than we sense them to be – what has been called the Grand Illusion.[27] However, few, if any, other authors suggest the existence of multiple partial "drafts". Moreover, also on the basis of recall experiments, Lamme[28] has challenged the idea that richness is illusory, emphasizing that phenomenal content cannot be equated with content to which there is cognitive access.

Dennett does not tie drafts to biophysical events. Multiple sites of causal convergence are invoked in specific biophysical terms by Edwards[29] and Sevush.[30] In this view the sensory signals to be combined in phenomenal experience are available, in full, at each of multiple sites. To avoid non-causal combination each site/event is placed within an individual neuronal dendritic tree. The advantage is that "compresence" is invoked just where convergence occurs neuro-anatomically. The disadvantage, as for Dennett, is the counter-intuitive concept of multiple "copies" of experience. The precise nature of an experiential event or "occasion", even if local, also remains uncertain.

The majority of theoretical frameworks for the unified richness of phenomenal experience adhere to the intuitive idea that experience exists

as a single copy, and draw on "functional" descriptions of distributed networks of cells. Baars[31] has suggested that certain signals, encoding what we experience, enter a "Global Workspace" within which they are "broadcast" to many sites in the cortex for parallel processing. Dehaene, Changeux and colleagues[32] have developed a detailed neuro-anatomical version of such a workspace. Tononi and colleagues[33] have suggested that the level of richness of an experience is determined by the narrowest information interface "bottleneck" in the largest sub-network or "complex" that acts as an integrated functional unit. Lamme[28] has suggested that networks supporting reciprocal signaling rather than those merely involved in feed-forward signaling support experience. Edelman and colleagues have also emphasized the importance of re-entrant signaling.[*citation needed*] Cleeremans[34] emphasizes meta-representation as the functional signature of signals contributing to consciousness.

In general, such network-based theories are not explicitly theories of how consciousness is unified, or "bound" but rather theories of functional domains within which signals contribute to unified conscious experience. A concern about functional domains is what Rosenberg[35] has called the boundary problem; it is hard to find a unique account of what is to be included and what excluded. Nevertheless, this is, if anything is, the consensus approach.

Within the network context, a role for synchrony has been invoked as a solution to the phenomenal binding problem as well as the computational one. In his book, The Astonishing Hypothesis,[36] Crick appears to be offering a solution to BP2 as much as BP1. Even von der Malsburg,[*citation needed*] introduces detailed computational arguments about object feature binding with remarks about a "psychological moment". The Singer group[*citation needed*] also appear to be interested as much in the role of synchrony in phenomenal awareness as in computational segregation.

The apparent incompatibility of using synchrony to both segregate and unify might be explained by sequential roles. However, Merker[12] points out what appears to be a contradiction in attempts to solve the phenomenal

unification problem (BP2) in terms of a functional (effectively meaning computational) rather than a local biophysical, domain, in the context of synchrony.

Functional arguments for a role for synchrony are in fact underpinned by analysis of local biophysical events. However, Merker[12] points out that the explanatory work is done by the downstream integration of synchronized signals in post-synaptic neurons: "It is, however, by no means clear what is to be understood by 'binding by synchrony' other than the threshold advantage conferred by synchrony at, and only at, sites of axonal convergence onto single dendritic trees..." In other words, although synchrony is proposed as a way of explaining binding on a distributed, rather than a convergent, basis the justification rests on what happens at convergence. Signals for two features are proposed as bound by synchrony because synchrony effects downstream convergent interaction. Any theory of phenomenal binding based on this sort of computational function would seem to follow the same principle. The phenomenality would entail convergence, if the computational function does.

Although BP1 and BP2 are different, this need not invalidate the assumption, implicit in many of the quoted models, that computational and phenomenal events, at least at some point in the sequence of events, parallel each other in some way. The difficulty remains in identifying what that way might be. Merker's[12] analysis suggests that either (1) both computational and phenomenal aspects of binding are determined by convergence of signals on neuronal dendritic trees, or (2) that our intuitive ideas about the need for "binding" in a "holding together" sense in both computational and phenomenal contexts are misconceived. We may be looking for something extra that is not needed. Merker, for instance, argues that the homotopic connectivity of sensory pathways does the necessary work.

The nature of, and solution to, BP2 remains a matter of controversy.

See also

- Frame problem
- Hard problem of consciousness
- Philosophy of perception
- Symbol grounding
- Binding neuron
- Neural coding

TOC Previous Next

References

1. ^ a b c d e f *Revonsuo, A.; Newman, J. (Jun 1999). "Binding and consciousness". Conscious Cogn. **8** (2): 123–7. doi:10.1006/ccog.1999.0393. PMID 10447994.*
2. ^ a b c d *Smythies, John R. (John Raymond) (1994). The walls of Plato's cave : the science and philosophy of (brain, consciousness, and perception. Aldershot ; Brookfield, USA: Avebury. ISBN 978-1-85628-882-8. OCLC 30156912.*
3. ^ *Canales, AF.; Gómez, DM.; Maffet, CR. (2007). "A critical assessment of the consciousness by synchrony hypothesis". Biol Res. **40** (4): 517–9. doi:10.4067/S0716-97602007000500012. PMID 18575683.*
4. ^ a b *Bartels, A.; Zeki, S. (Jul 2006). "The temporal order of binding visual attributes" (PDF). Vision Res. **46** (14): 2280–6. doi:10.1016/j.visres.2005.11.017. PMID 16387344.*[*permanent dead link*]
5. ^ *Milner PM (November 1974). "A model for visual shape recognition". Psychol Rev. **81** (6): 521–35. doi:10.1037/h0037149. PMID 4445414.*
6. ^ a b c *Shadlen MN, Movshon JA (September 1999). "Synchrony unbound: a critical evaluation of the temporal binding hypothesis". Neuron. **24** (1): 67–77, 111–25. doi:10.1016/S0896-6273(00)80822-3. PMID 10677027.*
7. ^ von der Malsburg, C. (1981). The correlation theory of brain function. MPI Biophysical Chemistry, Internal Report 81–2. Reprinted in Mod- els of Neural Networks II (1994), E. Domany, J.L. van Hemmen, and K. Schulten, eds. (Berlin: Springer).
8. ^ *Engel AK, König P, Gray CM, Singer W (1990). "Stimulus-Dependent Neuronal Oscillations in Cat Visual Cortex: Inter-Columnar Interaction as Determined by Cross-Correlation Analysis" (PDF). Eur. J. Neurosci. **2** (7): 588–606. doi:10.1111/j.1460-9568.1990.tb00449.x. PMID 12106294.*
9. ^ *Thiele, A.; Stoner, G. (2003), "Neuronal synchrony does not correlate with motion coherence in cortical area MT", Nature, **421** (6921): 366–370, doi:10.1038/nature01285, PMID 12540900*

10. ^ *Dong, Y.; Mihalas, S.; Qiu, F.; von der Heydt, R. & Niebur, E. (2008), "Synchrony and the binding problem in macaque visual cortex", Journal of Vision,* ***8*** *(7): 1–16, doi:10.1167/8.7.30, PMC 2647779 , PMID 19146262*
11. ^ *Singer, Wolf (2007). "Binding by synchrony". Scholarpedia.* ***2*** *(12): 1657. doi:10.4249/scholarpedia.1657. ISSN 1941-6016.*
12. ^ a b c d e f *Merker B (March 2013). "Cortical gamma oscillations: the functional key is activation, not cognition". Neurosci Biobehav Rev.* ***37*** *(3): 401–17. doi:10.1016/j.neubiorev.2013.01.013. PMID 23333264.*
13. ^ a b *Seth, A. K. (2004). "Visual Binding Through Reentrant Connectivity and Dynamic Synchronization in a Brain-based Device". Cerebral Cortex.* ***14*** *(11): 1185–1199. doi:10.1093/cercor/bhh079. PMID 15142952.*
14. ^ *Goldfarb, L.; Treisman, A. (Mar 2013). "Counting multidimensional objects: implications for the neural-synchrony theory". Psychological Science.* ***24*** *(3): 266–71. doi:10.1177/0956797612459761. PMID 23334446.*
15. ^ *von der Malsburg, C. (Sep 1999). "The what and why of binding: the modeler's perspective" (PDF). Neuron.* ***24*** *(1): 95–104, 111–25. doi:10.1016/s0896-6273(00)80825-9. PMID 10677030.*
16. ^ Purves, D. and Lotto, R. B. (2003) Why we see what we do: An empirical theory of vision. Sunderland, MA: Sinauer Associates.
17. ^ *Pylyshyn, ZW. (Jun 2001). "Visual indexes, preconceptual objects, and situated vision". Cognition.* ***80*** *(1-2): 127–58. doi:10.1016/S0010-0277(00)00156-6. PMID 11245842.*
18. ^ *Treisman, A.; Gelade, G. (1980), "A feature integration theory of attention." (PDF), Cognitive Psychology,* ***12*** *(1): 97–136, doi:10.1016/0010-0285(80)90005-5, PMID 7351125, archived from the original (PDF) on 2008-09-05*
19. ^ Marr, D. C. (1982) Vision. New York, Freeman.
20. ^ *Barlow, H. (1972). "Single units and sensation: A neuron doctrine for perceptual psychology?". Perception.* ***1*** *(4): 371–394. doi:10.1068/p010371.*
21. ^ Zimmer, H.D., Mecklinger, A. and Lindenberger, U. (2006) Binding in human memory: A neurocognitive approach. Oxford University Press.

22. ^ Revonsuo, A, (2006) Inner Presence: Consciousness as a biological phenomenon. Cambridge, MA: MIT Press.
23. ^ The Unity of Consciousness. Stanford Encyclopaedia of Philosophy. http://plato.stanford.edu/entries/consciousness-unity/
24. ^ a b Bayne, T. and Chalmers, D. (2003) What is the unity of consciousness? In Cleeremans, A. The Unity of consciousness, Binding, Integration and Dissociation, Oxford University Press.
25. ^ Whitehead, A. N. (1929) Process and Reality. 1979 corrected edition, edited by David Ray Griffin and Donald W. Sherburne, Free Press. ISBN 0-02-934570-7
26. ^ a b Dennett, D.C. (1978) Brainstorms (Cambridge, MA: MIT Press)
27. ^ Blackmore, S. J., Brelstaff, G., Nelson, K., Troscianko, T. (1995), "Is the richness of our visual world an illusion? Transsaccadic memory for complex scenes", Perception, 24, pp. 1075–81.
28. ^ a b Lamme, V. (2002) The grand Grand Illusion illusion. Journal of Consciousness Studies, 9, 141–157.
29. ^ Edwards, J. C. (2005) Is consciousness only a property of individual cells? Journal of Consciousness Studies 12, 4-5, 60–76. Available at http://www.ucl.ac.uk/jonathan-edwards
30. ^ Sevush, S. (2006) Single neuron theory of consciousness. J. Theoretical Biology 238, 704–725.
31. ^ Baars, B. J. (1997), In the Theater of Consciousness New York, Oxford University Press.
32. ^ Dehaene, S., Sergent, C. and Changeux, J.-P. (2003). A neuronal network model linking subjective reports and objective physiological data during conscious perception. Proc. National Academy of Science (USA) 100. 14: 8520–8525.
33. ^ Balduzzi D, Tononi G. (2008) Integrated information in discrete dynamical systems: motivation and theoretical framework. *PLoS Comput Biol*. 4(6):e1000091. doi: 10.1371/ journal.pcbi.1000091
34. ^ Cleeremans, A. (2011) The radical plasticity thesis. Frontiers in Psychology 2, Article 86 doi: 10.3389/fpsyg.2011.00086
35. ^ Rosenberg, G. (2004) A Place for Consciousness. Oxford, Oxford University Press. ISBN 0-19-516814-3.
36. ^ Crick, F. (1995) The Astonishing Hypothesis. Scribner Paperback ISBN 0-684-80158-2 ISBN 978-0684801582

Further reading

- Zimmer, H. D. (Hubert D.); Mecklinger, Axel.; Lindenberger, Ulman. (2006). *Handbook of binding and memory : perspectives from cognitive neuroscience*. Oxford ; New York: Oxford University Press. ISBN 978-0-19-852967-5. OCLC 63702616.

TOC Previous

External links

Categories: Philosophy of mind | Attention | Cognition | Cognitive science | Memory | Perception | Unsolved problems in neuroscience

This page was last edited on 18 May 2018, at 15:37.

Back to main TOC

Contents

Spatial Ability

Jump to navigation Jump to search

Spatial ability or visuo-spatial ability is the capacity to understand, reason and remember the spatial relations among objects or space.[1]

Visual-spatial abilities are used for everyday use from navigation, understanding or fixing equipment, understanding or estimating distance and measurement, and performing on a job. Spatial abilities are also important for success in fields such as sports, technical aptitude, mathematics, natural sciences, engineering, economic forecasting, meteorology, chemistry and physics.[2][3] Not only do spatial abilities involve understanding the outside world, but they also involve processing outside information and reasoning with it through visual representation in the mind.

TOP

TOC Next

Definition and types

Spatial ability is the capacity to understand, reason and remember the spatial relations among objects or space.[1] There are four common types of spatial abilities which include spatial or visuo-spatial perception, spatial visualization, mental folding and mental rotation.[4] Each of these abilities have unique properties and importance to many types of tasks whether in certain jobs or everyday life. For example, spatial perception is defined as the ability to perceive spatial relationships in respect to the orientation of one's body despite distracting information.[5] mental rotation on the other hand is the mental ability to manipulate and rotate 2D or 3D objects in space quickly and accurately.[4] Lastly, spatial visualization is characterized as complicated multi-step manipulations of spatially presented information.[5] These three abilities are mediated and supported by a fourth spatial cognitive factor known as spatial working memory. Spatial working memory is the ability to temporarily store a certain amount of visual-spatial memories under attentional control in order to complete a task.[6] This cognitive ability mediates individual differences in the capacity for higher level spatial abilities such as mental rotation.

Spatial perception

Spatial perception is defined as the ability to perceive spatial relationships in respect to the orientation of one's body despite distracting information.[4] It consists of being able to perceive and visually understand outside spatial information such as features, properties, measurement, shapes, position and motion.[7] For example, when one is navigating through a dense forest they are using spatial perception and awareness. Or another example is when trying to understand the relations and mechanics inside of a car, he or she is relying on their spatial perception to understand it's visual framework. Tests that measure spatial perception include the Rod and Frame test, where subjects must place a rod vertically while viewing a frame orientation of 22 degrees in angle, or the Water Level task, where

subjects have to draw or identify a horizontal line in a tilted bottle.[5]

Spatial perception is also very relevant in sports. For example, a study found that cricket players who were faster at picking up information from briefly presented visual displays were significantly better batsmen in an actual game.[8] A 2015 study published in the *Journal of Vision* found that soccer players had higher perceptual ability for body kinematics such as processing multitasking crowd scenes which involve pedestrians crossing a street or complex dynamic visual scenes.[9] Another study published in the *Journal of Human Kinetics* on fencing athletes found that achievement level was highly correlated with spatial perceptual skills such as visual discrimination, visual-spatial relationships, visual sequential memory, narrow attentional focus and visual information processing.[10] A review published in the journal of *Neuropsychologia* found that spatial perception involves attributing meaning to an object or space, so that their sensory processing is actually part of semantic processing of the incoming visual information.[11] The review also found that spatial perception involves the human visual system in the brain and the parietal lobule which is responsible for visuomotor processing and visually goal-directed action.[11] Studies have also found that individuals who played first person shooting games had better spatial perceptual skills like faster and more accurate performance in a peripheral and identification task while simultaneously performing a central search.[12] Researchers suggested that, in addition to enhancing the ability to divide attention, playing action games significantly enhances perceptual skills like top-down guidance of attention to possible target locations.[12]

TOC | Previous | Next

Mental Rotation

Mental rotation is the ability to mentally represent and *rotate* 2D and 3D objects in space quickly and accurately, while the object's features remain unchanged. Mental representations of physical objects can help utilize problem solving and understanding. For example, Hegarty (2004) showed that people manipulate mental representations for reasoning about mechanical problems, such as how gears or pulleys work.[13] Similarly,

Schwartz and Black (1999) found that doing such mental simulations such as pouring water improves people's skill to find the solution to questions about the amount of tilt required for containers of different heights and widths.[13] In the field of sports psychology, coaches for a variety of sports (e.g. basketball, gymnastics, soccer or golf) have promoted players to use mental imagery and manipulation as one technique for performance in their game. (Jones & Stuth, 1997)[13] Recent research (e.g., Cherney, 2008) has also demonstrated evidence that playing video games with consistent practice can improve mental rotation skills, for example improvements in women's scores after practice with a game that involved a race within a 3-D environment.[13] Same effects have been seen playing action video games such as Unreal Tournament as well as the popular mainstream game Tetris.[14] Jigsaw puzzles and Rubik's cube are also activities that involve higher level of mental rotation and can be practiced to improve spatial abilities over time.[15][16][17]

Mental rotation is also unique and distinct from the other spatial abilities because it also involves areas associated with motor simulation in the brain.[18]

Spatial visualization

Spatial visualization is characterized as complicated multi-step manipulations of spatially presented information.[5] It involves visual imagery which is the ability to mentally represent visual appearances of an object, and spatial imagery which consists of mentally representing spatial relations between the parts or locations of the objects or movements.[19]

Spatial visualization is especially important in the domains of science and technology. For example, an astronomer must mentally visualize the structures of a solar system and the motions of the objects within it.[2] An engineer mentally visualizes the interactions of the parts of a machine or building that he or she is assigned to design or work with.[2] Chemists must be able to understand formulas which can be viewed as abstract models of

molecules with most of the spatial information deleted; spatial skills are important in restoring that information when more detailed mental models of the molecules are needed in the formulas.[2]

Spatial visualization also involves imagining and working with visual details of measurement, shapes, motion, features and properties through mental imagery and using this spatial relations to derive at an understanding to a problem. Whereas spatial perception involves understanding externally via the senses, spatial visualization is the understanding internally through mental imagery in one's mind.

Another critical spatial visualization ability is **mental animation**.[20] Mental animation is mentally visualizing the motion and movement of components within any form of system or in general.[20] It is an ability highly crucial in mechanical reasoning and understanding, for example mental animation in mechanical tasks can involve deconstructing a pulley system mentally into smaller units and animating them in the corresponding sequence or laws in the mechanical system.[21] In short, mental animation is mental imagining how mechanical objects work by analyzing the motion of their smaller parts.

Mental folding is a complex spatial visualization that involves the *folding* of 2D pattern or material into 3D objects and representations.[22] Compared to other studies, mental folding has had relatively little research and study. In comparison to mental rotation, mental folding is a non-rigid spatial transformation ability which means features of the manipulated object end up changing unlike mental rotation. In rigid manipulations, the object itself is not changed but rather its spatial position or orientation is, whereas in non-rigid transformations like mental folding the object and shapes are changed.[23] Mental folding in tasks usually require a series of mental rotations to sequentially fold the object into a new one. Classic mental folding tests are the Paper folding task which is similar to Origami. Origami also requires mental folding by assessing folding a 2D paper enough times to create a 3D figure.[22]

Visual penetrative ability is least common spatial visualization task which involves ability to imagine what is inside an object based on the

features outside.[24]

TOC Previous Next

Spatial working memory

Spatial working memory is the ability to temporarily store visual-spatial memories under attentional control, in order to complete a task.[6] This cognitive ability mediates individual differences in the capacity for higher level spatial abilities, such as mental rotation. Spatial working memory involves storing large amounts of short-term spatial memories in relation to visuo-spatial sketchpad.It is used in the temporary storage and manipulation of visual-spatial information such as memorizing shapes, colours, location or motion of objects in space. It is also involved in tasks which consist of planning of spatial movements, like planning one's route through a complex building. The visuospatial sketchpad can be split into separate visual, spatial and possibly kin-aesthetic (movement) components. Its neurobiological function also correlates within the right hemisphere of the brain.[25]

TOC Previous Next

Vocational applications

Researchers have found that spatial ability plays an important role in advanced educational credentials in the science, technology, engineering or math (STEM).[26][27] From studies, it has been indicated that the probability of getting an advanced degree in STEM increases in positive relation to the level of one's spatial ability. For example, a 2009 study published in the Journal of Educational Psychology found that 45% of those with STEM PhDs were within top percentage of high spatial ability in a group of 400,000 participants who were analyzed for 11 years since they were in the 12th grade.[26] Only less than 10% of those with STEM PhDs were below the top quarter in spatial ability during adolescence.[26] The researchers then concluded how important spatial ability is for STEM and as a factor in achieving advanced educational success in that field.[26]

Spatial visualization is especially important in science and technology. For example, an astronomer must visually imagine the structures of a solar system, and the path of the bodies within it.[2] An engineer must visually imagine the motions of the parts of a machine or building that he or she is assigned to work with.[2] Chemists must be able to understand formulas which are essentially abstract models supposed to represent spatial dynamics of molecules, and thus spatial skills are important in visualizing the molecule models that are needed in the formulas.[2] Spatial manipulation ability is also important in the field of structural geology, when visually imagining how rocks change through time, such as migration of a magma body through crust or progressive folding of a strati-graphic succession. Another spatial visualization skill known as *visual penetrative ability* is important in geology as it requires geologists to visualize what is inside of a solid object based on past knowledge.[24]

Current literature also indicates that mathematics involves visuo-spatial processing. Studies have found that gifted students in math, for instance, perform better in spatial visualization than non-gifted students.[19] A 2008

review published in the journal of *Neuroscience Biobehavioural Reviews* found evidence that visuo-spatial processing is intuitively involved in many aspects of processing numbers and calculating in math. For example, meaning of a digit in a multi-digit number is coded following spatial information given its relation to its position within the number.[28] Another study found that numerical estimation might rely on integrating different visual-spatial cues (diameter, size, location, measurement) to infer an answer.[29] A study published in 2014 also found evidence that mathematical calculation relies on the integration of various spatial processes.[30] Another 2015 study published in the journal of *Frontiers in Psychology* also found that numerical processing and arithmetic performance may rely on visual perceptual ability.[31]

A 2007 study published in the journal of *Cognitive Science* also found that spatial visualization ability is crucial for solving kinematic problems in physics. Nonetheless, current literature indicates that spatial abilities specifically mental rotation, is crucial for achieving success in various fields of chemistry, engineering and physics.[3][32]

TOC Previous Next

See also

- Mechanical aptitude
- Motor imagery
- Raven's progressive matrices
- Spatial contextual awareness

External links

- Overview-Visual Spatial skills
- Recognizing Spatial Intelligence
- Spatial Ability Test, *Alaska Research Group*.

TOC Previous

References

1. ^ a b "Spatial ability" (PDF). www.jhu.edu. Johns Hopkins University.
2. ^ a b c d e f g Johns Hopkins University. "What is spatial ability?" (PDF). Johns Hopkins University.
3. ^ a b (us), National Academy of Sciences; (us), National Academy of Engineering; Engineering, and Institute of Medicine (US) Committee on Maximizing the Potential of Women in Academic Science and (2006-01-01). "Women in Science and Mathematics".
4. ^ a b c Donnon, Tyrone; DesCôteaux, Jean-Gaston; Violato, Claudio (2005-10-01). "Impact of cognitive imaging and sex differences on the development of laparoscopic suturing skills". Canadian Journal of Surgery. **48** (5): 387–393. ISSN 0008-428X. PMC 3211902 . PMID 16248138.
5. ^ a b c d Linn, Marcia C.; Petersen, Anne C. "Emergence and Characterization of Sex Differences in Spatial Ability: A Meta-Analysis". Child Development. **56** (6): 1479–1498. doi:10.1111/j.1467-8624.1985.tb00213.x.
6. ^ a b Shelton, Jill T.; Elliott, Emily M.; Hill, B. D.; Calamia, Matthew R.; Gouvier, Wm. Drew (2009-05-01). "A Comparison of Laboratory and Clinical Working Memory Tests and Their Prediction of Fluid Intelligence". Intelligence. **37** (3): 283. doi:10.1016/j.intell.2008.11.005. ISSN 0160-2896. PMC 2818304 . PMID 20161647.
7. ^ Simmons, Alison (2003). "Spatial Perception from a Cartesian Point of View" (PDF). Philosophical Topics 31.
8. ^ Deary, I. J.; Mitchell, H. (1989-01-01). "Inspection time and high-speed ball games". Perception. **18** (6): 789–792. doi:10.1068/p180789. ISSN 0301-0066. PMID 2628929.
9. ^ Romeas, Thomas; Faubert, Jocelyn (2015-09-01). "Assessment of sport specific and non-specific biological motion perception in soccer athletes shows a fundamental perceptual ability advantage over non-athletes for recognizing body kinematics". Journal of Vision. **15** (12): 504. doi:10.1167/15.12.504. ISSN 1534-7362.

10. ^ *Hijazi, Mona Mohamed Kamal (2013-12-31). "Attention, Visual Perception and their Relationship to Sport Performance in Fencing". Journal of Human Kinetics.* ***39****: 195–201. doi:10.2478/hukin-2013-0082. ISSN 1640-5544. PMC 3916930 . PMID 24511355.*
11. ^ a b *Jeannerod, M.; Jacob, P. (2005-01-01). "Visual cognition: a new look at the two-visual systems model". Neuropsychologia.* ***43*** *(2): 301–312. doi:10.1016/j.neuropsychologia.2004.11.016. ISSN 0028-3932. PMID 15707914.*
12. ^ a b *Wu, Sijing; Spence, Ian (2013-05-01). "Playing shooter and driving videogames improves top-down guidance in visual search". Attention, Perception, & Psychophysics.* ***75*** *(4): 673–686. doi:10.3758/s13414-013-0440-2. ISSN 1943-393X. PMID 23460295.*
13. ^ a b c d *"Online Psychology Laboratory - About Mental Rotation". opl.apa.org. Retrieved 2016-01-09.*
14. ^ *Latham, Andrew J.; Patston, Lucy L. M.; Tippett, Lynette J. (2013-09-13). "The virtual brain: 30 years of video-game play and cognitive abilities". Frontiers in Psychology.* ***4****. doi:10.3389/fpsyg.2013.00629. ISSN 1664-1078. PMC 3772618 . PMID 24062712.*
15. ^ *Levine, S.C.; Ratliff, K.R.; Huttenlocher, J.; Cannon, J. (2012-03-01). "Early Puzzle Play: A predictor of preschoolers' spatial transformation skill". Developmental Psychology.* ***48*** *(2): 530–542. doi:10.1037/a0025913. ISSN 0012-1649. PMC 3289766 . PMID 22040312.*
16. ^ *Baron-Cohen, Simon; Ashwin, Emma; Ashwin, Chris; Tavassoli, Teresa; Chakrabarti, Bhismadev (2009-05-27). "Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity". Philosophical Transactions of the Royal Society B: Biological Sciences.* ***364*** *(1522): 1377–1383. doi:10.1098/rstb.2008.0337. ISSN 0962-8436. PMC 2677592 . PMID 19528020.*
17. ^ *Hopkins, J. Roy (2014-05-10). Adolescence: The Transitional Years. Academic Press. ISBN 9781483265650.*
18. ^ *Zacks, Jeffrey M. (2008-01-01). "Neuroimaging studies of mental rotation: a meta-analysis and review". Journal of Cognitive Neuroscience.* ***20*** *(1): 1–19. doi:10.1162/jocn.2008.20013. ISSN 0898-929X. PMID 17919082.*
19. ^ a b *Van Garderen, Delinda (2006). "Spatial Visualization, Visual*

Imagery, and Mathematical Problem Solving of Students With Varying Abilities" (PDF). *JOURNAL OF LEARNING DISABILITIES VOLUME 39, NUMBER 6.*

20. ^ a b *Sims, V. K.; Hegarty, M. (1997-05-01). "Mental animation in the visuospatial sketchpad: evidence from dual-task studies". Memory & Cognition.* ***25*** *(3): 321–332. doi:10.3758/bf03211288. ISSN 0090-502X. PMID 9184484.*
21. ^ *Hegarty, M. (1992-09-01). "Mental animation: inferring motion from static displays of mechanical systems". Journal of Experimental Psychology. Learning, Memory, and Cognition.* ***18*** *(5): 1084–1102. doi:10.1037/0278-7393.18.5.1084. ISSN 0278-7393. PMID 1402712.*
22. ^ a b *Glass, Leila; Krueger, Frank; Solomon, Jeffrey; Raymont, Vanessa; Grafman, Jordan (2013-07-01). "Mental Paper Folding Performance Following Penetrating Traumatic Brain Injury in Combat Veterans: A Lesion Mapping Study". Cerebral Cortex (New York, NY).* ***23*** *(7): 1663–1672. doi:10.1093/cercor/bhs153. ISSN 1047-3211. PMC 3673178 . PMID 22669970.*
23. ^ *Harris, Justin; Hirsh-Pasek, Kathy; Newcombe, Nora S. (2013-05-01). "Understanding spatial transformations: similarities and differences between mental rotation and mental folding". Cognitive Processing.* ***14*** *(2): 105–115. doi:10.1007/s10339-013-0544-6. ISSN 1612-4790. PMID 23397105.*
24. ^ a b *Titus, Sarah (2009). "Characterizing and Improving Spatial Visualization Skills". Journal of Geoscience Education.*
25. ^ *Baddeley, A.D. (2000). "The episodic buffer: A new component of working memory?". Trends in Cognitive Sciences.* ***4*** *(11): 417–423. doi:10.1016/S1364-6613(00)01538-2. PMID 11058819.*
26. ^ a b c d *Wai, Jonathan (2009). "Spatial Ability for STEM Domains: Aligning Over 50 Years of cumulative psychological Knowledge solidifies Its importance"* (PDF). *Journal of Educational Psychology. doi:10.1037/a0016127.*
27. ^ *Tosto, Maria Grazia; Hanscombe, Ken B.; Haworth, Claire M.A.; Davis, Oliver S.P.; Petrill, Stephen A.; Dale, Philip S.; Malykh, Sergey; Plomin, Robert; Kovas, Yulia (2014-05-01). "Why do spatial abilities predict mathematical performance?". Developmental Science.* ***17*** *(3): 462–470. doi:10.1111/desc.12138. ISSN 1363-755X.*

PMC 3997754 . PMID 24410830.

28. ^ *de Hevia, Maria Dolores; Vallar, Giuseppe; Girelli, Luisa (2008-10-01). "Visualizing numbers in the mind's eye: the role of visuo-spatial processes in numerical abilities". Neuroscience and Biobehavioral Reviews. **32** (8): 1361–1372. doi:10.1016/j.neubiorev.2008.05.015. ISSN 0149-7634. PMID 18584868.*
29. ^ *Gebuis, Titia; Reynvoet, Bert (2012-01-01). "The role of visual information in numerosity estimation". PLOS ONE. **7** (5): e37426. doi:10.1371/journal.pone.0037426. ISSN 1932-6203. PMC 3355123 . PMID 22616007.*
30. ^ *Marghetis, Tyler; Núñez, Rafael; Bergen, Benjamin K. (2014-01-01). "Doing arithmetic by hand: hand movements during exact arithmetic reveal systematic, dynamic spatial processing". Quarterly Journal of Experimental Psychology. **67** (8): 1579–1596. doi:10.1080/17470218.2014.897359. ISSN 1747-0226. PMID 25051274.*
31. ^ *Zhou, Xinlin; Wei, Wei; Zhang, Yiyun; Cui, Jiaxin; Chen, Chuansheng (2015-01-01). "Visual perception can account for the close relation between numerosity processing and computational fluency". Frontiers in Psychology. **6**: 1364. doi:10.3389/fpsyg.2015.01364. ISSN 1664-1078. PMC 4563146 . PMID 26441740.*
32. ^ *"Spatial Ability in Learning Engineering Mechanics: Critical Review". ResearchGate. doi:10.1061/(ASCE)EI.1943-5541.0000266. Retrieved 2016-01-15.*

Categories:

- Cognitive science
- Cognitive tests
- Visual thinking
- Vision

Back to main TOC

Contents

Modularity of Mind

Jump to navigation Jump to search

Modularity of mind is the notion that a mind may, at least in part, be composed of innate neural structures or modules which have distinct established evolutionarily developed functions. Somewhat different definitions of "module" have been proposed by different authors.

TOP

TOC Next

Early investigations

Historically, questions regarding the *functional architecture* of the mind have been divided into two different theories of the nature of the faculties. The first can be characterized as a horizontal view because it refers to mental processes as if they are interactions between faculties such as memory, imagination, judgement, and perception, which are not domain specific (e.g., a judgement remains a judgement whether it refers to a perceptual experience or to the conceptualization/comprehension process). The second can be characterized as a vertical view because it claims that the mental faculties are differentiated on the basis of domain specificity, are genetically determined, are associated with distinct neurological structures, and are computationally autonomous.

The vertical vision goes back to the 19th century movement called phrenology and its founder Franz Joseph Gall, who claimed that the individual mental faculties could be associated precisely, in a sort of one-to-one correspondence, with specific physical areas of the brain. Hence, someone's level of intelligence, for example, could be literally "read off" from the size of a particular bump on his posterior parietal lobe. This simplistic view of modularity has been disproven over the course of the last century.

Fodor's *Modularity of Mind*

In the 1980s, however, Jerry Fodor revived the idea of the modularity of mind, although without the notion of precise physical localizability. Drawing from Noam Chomsky's idea of the language acquisition device and other work in linguistics as well as from the philosophy of mind and the implications of optical illusions, he became a major proponent of the idea with the 1983 publication of *Modularity of Mind*.[1]

According to Fodor, a module falls somewhere between the behaviorist and cognitivist views of lower-level processes.

Behaviorists tried to replace the mind with reflexes which Fodor describes as encapsulated (cognitively impenetrable or unaffected by other cognitive domains) and non-inferential (straight pathways with no information added). Low level processes are unlike reflexes in that they are inferential. This can be demonstrated by poverty of the stimulus arguments in which the proximate stimulus, that which is initially received by the brain (such as the 2D image received by the retina), cannot account for the resulting output (for example, our 3D perception of the world), thus necessitating some form of computation.

In contrast, cognitivists saw lower level processes as continuous with higher level processes, being inferential and cognitively penetrable (influenced by other cognitive domains, such as beliefs). The latter has been shown to be untrue in some cases, such as with many visual illusions (ex. Müller-Lyer illusion), which can persist despite a person's awareness of their existence. This is taken to indicate that other domains, including one's beliefs, cannot influence such processes.

Fodor arrives at the conclusion that such processes are inferential like higher order processes and encapsulated in the same sense as reflexes.

Although he argued for the modularity of "lower level" cognitive processes in *Modularity of Mind* he also argued that higher level cognitive processes are not modular since they have dissimilar properties. *The Mind Doesn't*

Work That Way, a reaction to Steven Pinker's *How the Mind Works*, is devoted to this subject.

Fodor (1983) states that modular systems must—at least to "some interesting extent"—fulfill certain properties:

1. Domain specificity: modules only operate on certain kinds of inputs—they are specialised
2. Informational encapsulation: modules need not refer to other psychological systems in order to operate
3. Obligatory firing: modules process in a mandatory manner
4. Fast speed: probably due to the fact that they are encapsulated (thereby needing only to consult a restricted database) and mandatory (time need not be wasted in determining whether or not to process incoming input)
5. Shallow outputs: the output of modules is very simple
6. Limited accessibility
7. Characteristic ontogeny: there is a regularity of development
8. Fixed neural architecture.

Pylyshyn (1999) has argued that while these properties tend to occur with modules, one—information encapsulation—stands out as being the real signature of a module; that is the encapsulation of the processes inside the module from both cognitive influence and from cognitive access.[2] One example is that conscious awareness of the Müller-Lyer illusion being an illusion does not correct visual processing.[3]

Evolutionary psychology and massive modularity

Other perspectives on modularity come from evolutionary psychology, particularly from the work of Leda Cosmides and John Tooby. This perspective suggests that modules are units of mental processing that evolved in response to selection pressures. On this view, much modern human psychological activity is rooted in adaptations that occurred earlier in human evolution, when natural selection was forming the modern human species.

Evolutionary psychologists propose that the mind is made up of genetically influenced and domain-specific[4] mental algorithms or computational modules, designed to solve specific evolutionary problems of the past.[5] Cosmides and Tooby also state in a brief "primer" on their website,[6] that "…the brain is a physical system. It functions like a computer," "…the brain's function is to process information," "different neural circuits are specialized for solving different adaptive problems," and "our modern skulls house a stone age mind."

The definition of *module* has caused confusion and dispute. J. A. Fodor initially defined module as "functionally specialized cognitive systems" that have nine features but not necessarily all at the same time. In his views modules can be found in peripheral processing such as low-level visual processing but not in central processing. Later he narrowed the two essential features to *domain-specificity* and *information encapsulation*. Frankenhuis and Ploeger[3] write that domain-specificity means that "a given cognitive mechanism accepts, or is specialized to operate on, only a specific class of information". Information encapsulation means that information processing in the module cannot be affected by information in the rest of the brain. One example is that being aware that a certain optical illusion, caused by low level processing, is false does not prevent the illusion from persisting.[3]

Evolutionary psychologists instead usually define modules as functionally specialized cognitive systems that are domain-specific and may also

contain innate knowledge about the class of information processed. Modules can be found also for central processing. This theory is sometimes referred to as *massive modularity*.[3]

A 2010 review by evolutionary psychologists Confer et al. suggested that domain general theories, such as for "rationality," has several problems: 1. Evolutionary theories using the idea of numerous domain-specific adaptions have produced testable predictions that have been empirically confirmed; the theory of domain-general rational thought has produced no such predictions or confirmations. 2. The rapidity of responses such as jealousy due to infidelity indicates a domain-specific dedicated module rather than a general, deliberate, rational calculation of consequences. 3. Reactions may occur instinctively (consistent with innate knowledge) even if a person has not learned such knowledge. One example being that in the ancestral environment it is unlikely that males during development learn that infidelity (usually secret) may cause paternal uncertainty (from observing the phenotypes of children born many months later and making a statistical conclusion from the phenotype dissimilarity to the cuckolded fathers).[7] With respect to general purpose problem solvers, Barkow, Cosmides, and Tooby (1992) have suggested in *The Adapted Mind: Evolutionary Psychology and The Generation of Culture* that a purely general problem solving mechanism is impossible to build due to the frame problem. Clune et al. (2013) have argued that computer simulations of the evolution of neural nets suggest that modularity evolves because, compared to non-modular networks, connection costs are lower.[8]

Several groups of critics, including psychologists working within evolutionary frameworks,[9] argue that the massively modular theory of mind does little to explain adaptive psychological traits. Proponents of other models of the mind argue that the computational theory of mind is no better at explaining human behavior than a theory with mind entirely a product of the environment. Even within evolutionary psychology there is discussion about the degree of modularity, either as a few generalist modules or as many highly specific modules.[9][10] Other critics suggest that there is little empirical support in favor of the domain-specific theory beyond performance on the Wason selection task, a task critics state is too limited in scope to test all relevant aspects of reasoning.[11][12]

Moreover, critics argue that Cosmides and Tooby's conclusions contain several inferential errors and that the authors use untested evolutionary assumptions to eliminate rival reasoning theories.[11][13]

Wallace (2010) observes that the evolutionary psychologists' definition of "mind" has been heavily influenced by cognitivism and/or information processing definitions of the mind.[14] Critics point out that these assumptions underlying evolutionary psychologists' hypotheses are controversial and have been contested by some psychologists, philosophers, and neuroscientists. For example, Jaak Panksepp, an affective neuroscientist, point to the "remarkable degree of neocortical plasticity within the human brain, especially during development" and states that "the developmental interactions among ancient special-purpose circuits and more recent general-purpose brain mechanisms can generate many of the "modularized" human abilities that evolutionary psychology has entertained."[9]

Philosopher David Buller agrees with the general argument that the human mind has evolved over time but disagrees with the specific claims evolutionary psychologists make. He has argued that the contention that the mind consists of thousands of modules, including sexually dimorphic jealousy and parental investment modules, are unsupported by the available empirical evidence.[15] He has suggested that the "modules" result from the brain's developmental plasticity and that they are adaptive responses to local conditions, not past evolutionary environments.[16] However, Buller has also stated that even if massive modularity is false this does not necessarily have broad implications for evolutionary psychology. Evolution may create innate motives even without innate knowledge.[17]

In contrast to modular mental structure, some theories posit domain-general processing, in which mental activity is distributed across the brain and cannot be decomposed, even abstractly, into independent units. A staunch defender of this view is William Uttal, who argues in *The New Phrenology* (2003) that there are serious philosophical, theoretical, and methodological problems with the entire enterprise of trying to localise cognitive processes in the brain.[18] Part of this argument is that a

successful taxonomy of mental processes has yet to be developed.

Merlin Donald argues that over evolutionary time the mind has gained adaptive advantage from being a general problem solver.[19] The mind, as described by Donald, includes module-like "central" mechanisms, in addition to more recently evolved "domain-general" mechanisms.

See also

- Automatic and Controlled Processes (ACP)
- Faculty psychology
- Jerry Fodor on mental architecture
- Language module
- Modularity
- Neuroconstructivism
- Neuroplasticity
- Peter Carruthers (philosopher)
- Society of Mind which proposes the mind is made up of agents
- Visual modularity

References

1. ^ Fodor, Jerry A. (1983). *Modularity of Mind: An Essay on Faculty Psychology*. Cambridge, Massachusetts: MIT Press. ISBN 0-262-56025-9
2. ^ Pylyshyn, Z.W. (1999). Is vision continuous with cognition? The case for cognitive impenetrability of visual perception. Behavioral and Brain Sciences, 22(3), 341-423. Full text
3. ^ *a b c d* *Frankenhuis, W. E.; Ploeger, A. (2007). "Evolutionary Psychology Versus Fodor: Arguments for and Against the Massive Modularity Hypothesis". Philosophical Psychology.* ***20*** *(6): 687. doi:10.1080/09515080701665904.*
4. ^ Cosmides, L. & Tooby, J. (1994). Origins of Domain Specificity: The Evolution of Functional Organization. In L.A. Hirschfeld and S.A. Gelmen, eds., Mapping the Mind: Domain Specificity in Cognition and Culture. Cambridge: Cambridge University Press. Reprinted in R. Cummins and D.D. Cummins, eds., Minds, Brains, and Computers. Oxford: Blackwell, 2000, 523-543.
5. ^ Cosmides, L., & Tooby, J. (1992). Cognitive Adaptations for Social Exchange. In Barkow, Cosmides, and Tooby 1992, 163-228.
6. ^ *"Evolutionary Psychology Primer by Leda Cosmides and John Tooby". Psych.ucsb.edu. 1997-01-13. Retrieved 2012-07-23.*
7. ^ *Confer, J. C.; Easton, J. A.; Fleischman, D. S.; Goetz, C. D.; Lewis, D. M. G.; Perilloux, C.; Buss, D. M. (2010). "Evolutionary psychology: Controversies, questions, prospects, and limitations" (PDF). American Psychologist.* ***65*** *(2): 110–126. doi:10.1037/a0018413. PMID 20141266.*
8. ^ *Clune, Jeff; Mouret, Jean-Baptiste; Lipson, Hod (2013). "The evolutionary origins of modularity". Proceedings of the Royal Society.* ***280*** *(1755). arXiv:1207.2743 . doi:10.1098/rspb.2012.2863.*
9. ^ *a b c* Panksepp, J. & Panksepp, J. (2000). The Seven Sins of Evolutionary Psychology. Evolution and Cognition, 6:2, 108-131.
10. ^ Buller, David J. and Valerie Gray Hardcastle (2005) Chapter 4. "Modularity", in Buller, David J. The Adapted Mind: Evolutionary Psychology. The MIT Press. pp. 127 - 201

11. ^ [a] [b] *Davies, Paul Sheldon; Fetzer, James H.; Foster, Thomas R. (1995). "Logical reasoning and domain specificity". Biology and Philosophy.* ***10*** *(1): 1–37. doi:10.1007/BF00851985.*
12. ^ *O'Brien, David; Manfrinati, Angela (2010). "The Mental Logic Theory of Conditional Propositions". In Oaksford, Mike; Chater, Nick. Cognition and Conditionals: Probability and Logic in Human Thinking. New York: Oxford University Press. pp. 39–54. ISBN 978-0-19-923329-8.*
13. ^ *Lloyd, Elizabeth A. (1999). "Evolutionary Psychology: The Burdens of Proof" (PDF). Biology and Philosophy.* ***19*** *(2): 211–233. doi:10.1023/A:1006638501739. Retrieved October 6, 2014.*
14. ^ Wallace, B. (2010). Getting Darwin Wrong: Why Evolutionary Psychology Won't Work. Exeter, UK: Imprint Academic.
15. ^ *Buller, David J. (2005). "Evolutionary psychology: the emperor's new paradigm" (PDF). Trends in Cognitive Sciences.* ***9*** *(6): 277–283. doi:10.1016/j.tics.2005.04.003. PMID 15925806. Retrieved March 23, 2013.*
16. ^ *Buller, David J.; Hardcastle, Valerie (2000). "Evolutionary Psychology, Meet Developmental Neurobiology: Against Promiscuous Modularity" (PDF). Brain and Mind.* ***1*** *(3): 307–325. doi:10.1023/A:1011573226794. Retrieved March 23, 2013.*
17. ^ *Buller, David J. (2005). "Get Over: Massive Modularity" (PDF). Biology & Philosophy.* ***20*** *(4): 881–891. doi:10.1007/s10539-004-1602-3. Retrieved March 23, 2013.*
18. ^ Uttal, William R. (2003). *The New Phrenology: The Limits of Localizing Cognitive Processes in the Brain.* Cambridge, Massachusetts: MIT Press.
19. ^ Donald, *A Mind So Rare: The Evolution of Human Consciousness* [1].

Further reading

- Barrett, H.C., and Kurzban, R. (2006). Modularity in cognition: Framing the debate. *Psychological Review*, *113*, 628-647. Full text[permanent dead link]
- Pylyshyn, Z.W. (1984). *Computation and cognition: Toward a foundation for cognitive science*. Cambridge, Massachusetts: MIT Press (Also available through CogNet).
- *Animal Minds: Beyond Cognition to Consciousness* Donald R. Griffin, University of Chicago Press, 2001 (ISBN 0226308650)
- Shallice, Tim, & Cooper, Rick. (2011). *The Organisation of Mind*. Oxford: Oxford University Press. Chapter 3: Bridging the Theoretical Gap: from the Brain to Cognitive Theory (pp. 67–107).

Online videos

- RSA talk by evolutionary psychologist Robert Kurzban on modularity of mind, based on his book, *Why Everyone (Else) is a Hypocrite*
- Stone Age Minds: A conversation with evolutionary psychologists Leda Cosmides and John Tooby
- Video of a computer simulation of the evolution of modularity in neural nets.

Categories:

- Behavioural sciences
- Cognition
- Cognitive science
- Evolutionary psychology
- Ethology
- Theory of mind
- Semantics
- Cognitive architecture

This page was last edited on 22 May 2018, at 20:22.

Back to main TOC

Contents

Dual-coding Theory

Jump to navigation Jump to search

Dual-coding theory, a theory of cognition, was hypothesized by Allan Paivio of the University of Western Ontario in 1971. In developing this theory, Paivio used the idea that the formation of mental images aids in learning (Reed, 2010). According to Paivio, there are two ways a person could expand on learned material: verbal associations and visual imagery. Dual-coding theory postulates that both visual and verbal information is used to represent information (Sternberg, 2003). Visual and verbal information are processed differently and along distinct channels in the human mind, creating separate representations for information processed in each channel. The mental codes corresponding to these representations are used to organize incoming information that can be acted upon, stored, and retrieved for subsequent use. Both visual and verbal codes can be used when recalling information (Sternberg, 2003). For example, say a person has stored the stimulus concept "dog" as both the word 'dog' and as the image of a dog. When asked to recall the stimulus, the person can retrieve either the word or the image individually, or both simultaneously. If the word is recalled, the image of the dog is not lost and can still be retrieved at a later point in time. The ability to code a stimulus two different ways increases the chance of remembering that item compared to if the stimulus was only coded one way.

There has been controversy to the limitations of the dual-coding theory. Dual-coding theory does not take into account the possibility of cognition being mediated by something other than words and images. Not enough research has been done to determine if words and images are the only way we remember items, and the theory would not hold true if another form of codes were discovered (Pylyshyn, 1973). Another limitation of the dual-coding theory is that it is only valid for tests on which people are asked to focus on identifying how concepts are related (Reed, 2010). If associations between a word and an image cannot be formed, it is much harder to remember and recall the word at a later point in time. While this limits the

effectiveness of the dual-coding theory, it is still valid over a wide range of circumstances and can be used to improve memory (Reed, 2010).

Types of codes

Analogue codes are used to mentally represent images. Analogue codes retain the main perceptual features of whatever is being represented, so the images we form in our minds are highly similar to the physical stimuli. They are a near-exact representation of the physical stimuli we observe in our environment, such as trees and rivers (Sternberg, 2003).

Symbolic codes are used to form mental representations of words. They represent something conceptually, and sometimes, arbitrarily, as opposed to perceptually. Similar to the way a watch may represent information in the form of numbers to display the time, symbolic codes represent information in our mind in the form of arbitrary symbols, like words and combinations of words, to represent several ideas. Each symbol (x, y, 1, 2, etc.) can arbitrarily represent something other than itself. For instance, the letter x is often used to represent more than just the concept of an x, the 24th letter of the alphabet. It can be used to represent a variable x in mathematics, or a multiplication symbol in an equation. Concepts like multiplication can be represented symbolically by an "x" because we arbitrarily assign it a deeper concept. Only when we use it to represent this deeper concept does the letter "x" carry this type of meaning.

TOC Previous Next

Support

Evidence from psychological research

Many researchers have agreed that only words and images are used in mental representation (Pylyshyn, 1973). Supporting evidence shows that memory for some verbal information is enhanced if a relevant visual is also presented or if the learner can imagine a visual image to go with the verbal information. Likewise, visual information can often be enhanced when paired with relevant verbal information, whether real-world or imagined (Anderson & Bower, 1973). This theory has been applied to the use of multimedia presentations. Because multimedia presentations require both spatial and verbal working memory, individuals dually code information presented and are more likely to recall the information when tested at a later date (Brunye, Taylor, & Rapp, 2008). Moreover, studies that have been conducted on abstract and concrete words have also found that the participants remembered concrete words better than the abstract words (Hargis & Gickling, 1978; Sadoski, 2005; Yui, Ng, & Perera-W.A., 2017).

Paivio found that participants when shown a rapid sequence of pictures as well as a rapid sequence of words and later asked to recall the words and pictures, in any order, were better at recalling images. Participants, however, more readily recalled the sequential order of the words, rather than the sequence of pictures. These results supported Paivio's hypothesis that verbal information is processed differently from visual information and that verbal information was superior to visual information when sequential order was also required for the memory task (Paivio, 1969). Lee Brooks conducted an experiment that provided additional support for two systems for memory. He had participants perform either a visual task, where they had to view a picture and answer questions about the picture, or a verbal task, where they listened to a sentence and were then asked to answer questions pertaining to the sentence. To respond to the questions, participants were asked to either respond verbally, visually, or manually.

Through this experiment, Brooks found that interference occurred when a visual perception was mixed with manipulation of the visual task, and verbal responses interfere with a task involving a verbal statement to be manually manipulated. This supported the idea of two codes used to mentally represent information (Sternberg 2003).

Working memory as proposed by Alan Baddeley includes a two-part processing system with a visuospatial sketchpad and a phonological loop which essentially maps to Paivio's theory.

Dual-coding theories complement a dual-route theory of reading. When people read written information, dual-route theory contends that the readers access orthographic and phonological information to recognize words in the writing.

Paivio's work has implications for literacy, visual mnemonics, idea generation, HPT, human factors, interface design, as well as the development of educational materials among others. It also has implications for, and counterparts in, cognitive sciences and computational cognitive modeling (in the form of dual process cognitive models and so on; e.g., Anderson, 2005; Just et al., 2004, Sun, 2002). It also has had implications for cognitive robotics.

TOC Previous Next

Cognitive neuroscience support

Two different methods have been used to identify the regions involved in visual perception and visual imagery. Cerebral blood flow allows researchers to identify the amount of blood and oxygen traveling to a specific part of the brain, with an increase in blood flow providing a measure of brain activity. An event related potential can be used to show the amount of electrical brain activity that is occurring due to a particular stimulus. Researchers have used both methods to determine which areas of the brain are active with different stimuli, and results have supported the dual-coding theory. Other research has been done with positron emission tomography (PET) scans and functional magnetic resonance imaging

(fMRI) to show that participants had improved memory for spoken words and sentences when paired with an image, imagined or real, and showed increased brain activation to process abstract words not easily paired with an image.

Alternative theory

Dual-coding theory is not accepted by everyone. John Anderson and Gordon Bower proposed an alternative method – the propositional theory – of how knowledge is mentally represented. The propositional theory claims that mental representations are stored as propositions rather than as images. Here, proposition is defined as the meaning that underlies the relationship between concepts (Sternberg, 2003). This theory states that images occur as a result of other cognitive processes because knowledge is not represented in the form of images, words, or symbols.

The common coding theory has also been proposed as an alternative to dual coding theory. The common coding theory looks at how things we see and hear are connected to our motor actions. It claims that there is a common code that is shared between perceiving something and the respective motor action.

See also

- Multimedia learning

TOC | Previous | Next

References

- Anderson, J. R. (2005). Cognitive Psychology and its implications. New York: Worth Publishers.
- Anderson, J. R. & Bower, G. H. (1973). Human associative memory. Washington, DC: Winston.
- Baddeley, A. D. (1986). Working memory. Oxford: Oxford University Press.
- Brunye, T. T., Taylor, H. A., & Rapp, D. N. (2008). Repetition and dual coding in procedural multimedia presentations. *Applied Cognitive Psychology*, *22*, 877-895.
- Denis, M. and Mellet, E. (2002). Neural bases of image and language interactions. International Journal of Psychology, 37 (4), 204-208.
- Hargis, C. H., & Gickling, E. E. (1978). The function of imagery in word recognition development. The Reading Teacher, 31(8), 870-874.
- Just, M. et al. (2004). Imagery in sentence comprehension: an fMRI study. NeuroImage 21, 112-124.
- Mayer, R. E. & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. Educational Psychologist, 38(1), 43-52.
- Moreno, R., & Mayer, R. E. (2000). A coherence effect in multimedia learning: the case for minimizing irrelevant sounds in the design of multimedia instructional messages. Journal of Educational Psychology, 92, 117-125.
- Yui L, Ng R, Perera-W.A. H. (2017). Concrete vs abstract words – what do you recall better? A study on dual coding theory. PeerJ Preprints 5:e2719v1https://doi.org/10.7287/peerj.preprints.2719v1
- Paivio, A (1969). Mental Imagery in associative learning and memory. Psychological Review, 76(3), 241-263.
- Paivio, A (1971). Imagery and verbal processes. New York: Holt, Rinehart, and Winston.
- Paivio, A (1986). Mental representations: a dual coding approach. Oxford. England: Oxford University Press.
- *Sternberg, Robert J. (2006). Cognitive psychology fourth edition. Thomson Wadsworth. pp. 234–36. ISBN 0-534-51421-9*.
- Pylyshyn, Z. W. (1973). What the mind's eye tells the mind's brain: A critique of mental imagery. *Psychological Bulletin*, *80*, 1-24.

- Reed, S. K. (2010). Cognition: Theories and application (8th ed.). Belmont, CA: Wadsworth Cengage Learning.
- Sadoski, M., Willson, V. L., Holcomb, A., & Boulware-Gooden, R. (2005). Verbal and nonverbal predictors of spelling performance. Journal of Literacy Research, 36, 461–478.
- Sternberg, R. J. (2003). Cognitive theory (3rd ed.). Belmont, CA: Thomson Wadsworth.
- Sun, R. (2002). Duality of the Mind. Mahwah, NJ: Lawrence Erlbaum Associates.
- Thomas, N. J.T., "Mental imagery", *The Stanford Encyclopedia of Philosophy (Winter 2011 Edition)*, Edward N Zalta (ed.).

TOC Previous

External links

- Multiple Code Theory

Categories:

- Cognitive science
- Educational psychology
- Linguistics

This page was last edited on 5 December 2017, at 23:09.

Back to main TOC

Contents

Sense of Agency

Jump to navigation Jump to search

The **sense of agency** (**SA**), or **sense of control**, is the subjective awareness of initiating, executing, and controlling one's own volitional actions in the world.[1] It is the pre-reflective awareness or implicit sense that it is I who is executing bodily movement(s) or thinking thoughts. In normal, non-pathological experience, the SA is tightly integrated with one's "sense of ownership" (SO), which is the pre-reflective awareness or implicit sense that one is the owner of an action, movement or thought. If someone else were to move your arm (while you remained passive) you would certainly have sensed that it were your arm that moved and thus a sense of ownership (SO) for that movement. However, you would not have felt that you were the author of the movement; you would not have a sense of agency (SA).[2]

Normally SA and SO are tightly integrated, such that while typing one has an enduring, embodied, and tacit sense that "my own fingers are doing the moving" (SO) *and* that "the typing movements are controlled (or volitionally directed) by me" (SA). In patients suffering from certain forms of pathological experience (i.e., schizophrenia) the integration of SA and SO may become disrupted in some manner. In this case, movements may be executed or thoughts made manifest, for which the schizophrenic patient has a sense of ownership, but not a sense of agency.[*not verified in body*]

Regarding SA for both motor movements and thoughts, further distinctions may be found in both first-order (immediate, pre-reflective) experience[3] and higher-order (reflective or introspective) consciousness.[4][*page needed*] For example, while typing I have a sense of control and thus SA for the ongoing action of typing; this is an example of SA in first-order experience which is immediate and prior to any explicit intellectual reflection upon the typing actions *themselves*. In this case, I am not focusing on the typing movements *per se* but rather, I am involved with the task at hand. If I'm

subsequently asked if I just performed the action of typing, I can correctly attribute agency to myself. This is an example of a higher-order, reflective, conscious "attribution" of agency, which is a derivative notion stemming from the immediate, *pre*-reflective "sense" of agency.

Definition

The concept of agency implies an active organism, one who desires, makes plans, and carries out actions.[5] The sense of agency plays a pivotal role in cognitive development, including the first stage of self-awareness (or pre-theoretical experience of one's own mentality), which scaffolds theory of mind capacities.[6][*page needed*] Indeed, the ability to recognize oneself as the agent of a behavior is the way the self builds as an entity independent from the external world.[1] The sense of agency and its scientific study has important implications in social cognition, moral reasoning, and psychopathology. The conceptual distinction between SA and SO was defined by philosopher and phenomenologist Shaun Gallagher.[2] Using a different terminology, essentially the same distinction has been made by John Campbell,[7] and Lynn Stephens and George Graham.[4][*page needed*]

TOC Previous Next

Neuroscience

A number of experiments in normal individuals has been undertaken in order to determine the functional anatomy of the sense of agency. These experiments have consistently documented the role of the posterior parietal cortex as a critical link within the simulation network for self-recognition. Primary sources have reported that activation of the right inferior parietal lobe/temporoparietal junction correlates with the subjective sense of ownership in action execution,[8][*non-primary source needed*][9][*non-primary source needed*]and that posterior parietal lesions, especially on the right side, impair the ability of recognizing one's own body parts and self-attributing one's own movements.[10][*non-primary source needed*]

Accumulating evidence from functional neuroimaging studies, as well as lesion studies in neurological patients indicates that the right inferior parietal cortex, at the junction with the posterior temporal cortex (TPJ, temporoparietal junction), plays a critical role in the distinction between self-produced actions and actions perceived in others.[11] Lesions of this region can produce a variety of disorders associated with body knowledge and self-awareness such as anosognosia, asomatognosia, or somatoparaphrenia.[12] A primary source has reported that electrical stimulation of the TPJ can elicit out-of-body experiences (i.e., the experience of dissociation of self from the body).[13][*non-primary source needed*]

The investigation of the neural correlates of reciprocal imitation is extremely important because it provides an ecological paradigm (a situation close to everyday life) to address the issue of the sense of agency.[14] There is evidence that reciprocal imitation plays a constitutive role in the early development of an implicit sense of self as a social agent.[6][*page needed*]

A primary source has reported a functional neuroimaging experiment, where participants were scanned while they imitated an experimenter performing constructions with small objects and while the experimenter,

while performing such a manipulation, imitated the participants. Across both conditions, the participants' sense of ownership (the sense that it is I who am experiencing the movement or thought) as well as the visual and somatosensory inputs were similar or coincided. What differed between imitating and being imitated was the agent who initiated the action. The primary source reports that several key regions were involved in the two conditions of reciprocal imitation compared to a control condition (in which subjects acted differently from the experimenter), namely in the superior temporal sulcus, the temporoparietal cortex (TPJ), and the medial prefrontal cortex.[15][*non-primary source needed*]

Another approach to understanding the neuroscientific underpinnings of the sense of agency is to examine clinical conditions in which purposeful limb movement occurs *without* an associated sense of agency.[*citation needed*] The most clear clinical demonstration of this situation is alien hand syndrome. In this condition, associated with specific forms of brain damage, the affected individual loses the sense of agency without losing a sense of ownership of the affected body part.

TOC Previous Next

Agency and psychopathology

Marc Jeannerod proposed that the process of self-recognition operates covertly and effortlessly. It depends upon a set of mechanisms involving the processing of specific neural signals, from sensory as well as from central origin. Researchers have used experimental situations, in both healthy participants and schizophrenic patients, where these signals can be dissociated from each other and where self-recognition becomes ambiguous.[16][*full citation needed*] These situations reveal that there are two levels of self-recognition, an automatic level for action identification, and a conscious level for the sense of agency, which both rely on the same principle of congruence of the action-related signals.

Investigation of the sense of agency is important to explain positive symptoms of schizophrenia, like thought insertion and delusions of control.[*citation needed*] The core of the problem met by these patients is a disturbance of their sense of agency: the first rank symptoms, which represent one of the major features of the disease, are nothing but a loss of the ability to attribute their own thoughts, internal speech, covert or overt actions to themselves.[*citation needed*] Nonattributed or misattributed thoughts and actions then become a material for delusional interpretation and delirium.[17][*non-primary source needed*] One primary source reports that the feeling of alien control (i.e., delusions of control) during a movement task in schizophrenic patients is associated with an increased metabolic activity in the right inferior parietal cortex.[18][*non-primary source needed*]

TOC | Previous | Next

Other aspects of agency

While the conception of human agency is often confined to its exercise by individuals, Albert Bandura has argued that individuals often do not have direct control over social conditions or institutional practices that affect their lives; in these circumstances, well-being and security are sought through exercise of proxy agency.[19][*page needed*] For instance, individuals in such circumstances may attempt to persuade others who have expertise, influence, or power to act on their behalf to achieve the outcomes they desire.

Sense of agency has been argued as a prerequisite for human moral responsibility insofar as self agency underlies the expectation that individuals can be held responsible for their actions. [20][*non-primary source needed*]

TOC Previous Next

See also

- Common coding theory
- Empathic concern
- Locus of control – whether people believe that their choices, environmental factors, fate, and/or random chance is controlling their lives
- Mirror neurons
- Morality
- Motor cognition
- Neuroscience of free will

References

1. ^ *a* *b* Jeannerod, M. (2003). The mechanism of self-recognition in human. Behavioral Brain Research, 142, 1-15.
2. ^ *a* *b* Gallagher, S. (2000). Philosophical conceptions of the self: implications for cognitive science. Trends in Cognitive Sciences, 4, 14–21.
3. ^ Tsakiris M, Schütz-Bosbach S, Gallagher S (2007) On agency and body-ownership: phenomenological and neurocognitive reflections. Conscious Cogn 16:645–660
4. ^ *a* *b* Stephens, G. L., & Graham, G. (2000). *When self-consciousness breaks: Alien voices and inserted thoughts*. Cambridge, MA: MIT Press.[*page needed*]
5. ^ Lewis, M. (1990). Intention, consciousness, desires and development. Psychological Inquiry, 1, 278–283.
6. ^ *a* *b* Rochat, P. (1999). Early Social Cognition: Understanding Others in the First Months of Life. Mahawah, NJ: Lawrence Erlbaum Associates.[*page needed*]
7. ^ Campbell, John (1999): "Schizophrenia, the Space of Reasons, and Thinking as a Motor Process." Monist 82 (4), 609–625.
8. ^ Farrer, C., Franck, N., Georgieff, N., Frith, C. D., Decety, J., & Jeannerod, M. (2003). Modulating the experience of agency: a positron emission tomography study. NeuroImage 18, 324–333.[*non-primary source needed*]
9. ^ Ruby, P., & Decety, J. (2001). Effect of subjective perspective taking during simulation of action: A PET investigation of agency. Nature Neuroscience 4, 546–550.[*non-primary source needed*]
10. ^ Daprati, E., et al. (2000). Recognition of self produced movement in a case of severe neglect. Neurocase, 6, 477–486[*non-primary source needed*]
11. ^ Jackson, P.L., & Decety, J. (2004). Motor cognition: A new paradigm to study self other interactions. Current Opinion in Neurobiology, 14, 259–263.
12. ^ Berlucchi, G., & Aglioti, S. (1997). The body in the brain: neural bases of corporeal awareness. Trends in Neurosciences, 20, 560–564.
13. ^ Blanke, O., & Arzy, S. (2005). The out-of-body experience:

Disturbed self-processing at the temporo-parietal junction. Neuroscientist, 11, 16–24.[non-primary source needed]

14. ^ Decety, J., & Sommerville, J.A. (2003). Shared representations between self and others: A social cognitive neuroscience view. Trends in Cognitive Sciences, 7, 527–533.
15. ^ Decety, J., Chaminade, T., Grèzes, J. and Meltzoff, A.N. (2002). A PET exploration of the neural mechanisms involved in reciprocal imitation. Neuroimage 15, 265–272.[non-primary source needed]
16. ^ Jeannerod, M. (2008). The sense of agency and its disturbances in schizophrenia: a reappraisal. Experimental Brain Research[full citation needed]
17. ^ Farrer, C., Franck, N., Frith, C.D., Decety, J., Damato, T., & Jeannerod, M. (2004). Neural correlates of action attribution in schizophrenia. Psychiatry Research: Neuroimaging, 131, 31–44.[non-primary source needed]
18. ^ Spence, S.A., et al. (1997). A PET study of voluntary movement in schizophrenic patients experiencing passivity phenomena. Brain, 120, 1997–2011.[non-primary source needed]
19. ^ Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.[page needed]
20. ^ E.g., see Kahn, P.H. (1992). Obligatory and discretionary moral judgments. Child Development, 63, 416–430.[non-primary source needed]

TOC Previous

Further reading

- Gallagher, S. (2005). How the Body Shapes the Mind. Oxford University Press.
- Haggard, P., Eitam, B. (Eds.) (2015). The Sense of Agency. New York: Oxford University Press.
- Jeannerod, M. (1997). The cognitive neuroscience of action. Wiley–Blackwell.
- Morsella, E., Bargh, J.A., & Gollwitzer, P.M. (Eds.) (2009). Oxford Handbook of Human Action. New York: Oxford University Press.
- Roessler, J., & Eilan, N. (Eds.) (2003). Agency and self-awareness. New York: Oxford University Press.

Categories:

- Neuropsychology
- Self
- Cognitive science
- Cognitive neuroscience
- Motor control
- Psychopathology

This page was last edited on 29 October 2017, at 03:27.

Mental Process

Jump to navigation Jump to search
Not to be confused with mental protuberance, an anatomical feature of the chin.

Mental process or **mental function** are all the things that individuals can do with their minds. These include perception, memory, thinking (such as ideation, imagination, belief, reasoning, etc.), volition, and emotion.

Sometimes the term *cognitive function* is used instead.

A specific instance of engaging in cognitive Cognition process is a mental event. The *event* of perceiving something is different from the entire process, or *capacity* of perception — one's ability to perceive things. In other words, an instance of perceiving is different from the ability that makes those instances possible.

See also

- Outline of human intelligence — topic tree presenting the traits, capacities, models, and research fields of human intelligence, and more.
- Outline of thought — topic tree that identifies many types of thoughts, types of thinking, aspects of thought, related fields, and more.
- Cognition
- Cognitivism
- Mental event
- Neurocognitive
- Mental operations

External links

- Mental Processes at the US National Library of Medicine Medical Subject Headings (MeSH)

TOP

Categories:

- Cognitive science
- Mental processes

This page was last edited on 4 June 2018, at 09:22.

Back to main TOC

Contents

Einstellung Effect

Einstellung is the development of a mechanized state of mind. Often called a problem solving set, Einstellung refers to a person's predisposition to solve a given problem in a specific manner even though better or more appropriate methods of solving the problem exist. The Einstellung effect is the negative effect of previous experience when solving new problems. The Einstellung effect has been tested experimentally in many different contexts. The most famous example (which led to Luchins and Luchins' coining of the term)[*citation needed*] is the Luchins' water jar experiment, in which subjects were asked to solve a series of water jar problems. After solving many problems which had the same solution, subjects applied the same solution to later problems even though a simpler solution existed (Luchins, 1942).[1] Other experiments on the Einstellung effect can be found in *The Effect of Einstellung on Compositional Processes*[2] and *Rigidity of Behavior, A Variational Approach to the Effect of Einstellung*.[3]

Background

Einstellung literally means "setting" or "installation" as well as a person's "attitude" in German. Related to Einstellung is what is referred to as an Aufgabe (literally, "task" in German). The Aufgabe is the situation which could potentially invoke the Einstellung effect. It is a task which creates a tendency to execute a previously applicable behavior. In the Luchins and Luchins experiment a water jar problem served as the Aufgabe, or task.

Another phenomenon similar to Einstellung is functional fixedness (Duncker 1945).[4] Functional fixedness is an impaired ability to discover a new use for an object, owing to the subject's previous use of the object in a functionally dissimilar context. It can also be deemed a cognitive bias that limits a person to using an object only in the way it is traditionally used. Duncker also pointed out that the phenomenon occurs not only with physical objects, but also with mental objects or concepts (a point which lends itself nicely to the phenomenon of Einstellung effect).

The Einstellung effect occurs when a person is presented with a problem or situation that is similar to problems they have worked through in the past. If the solution (or appropriate behavior) to the problem/situation has been the same in each past experience, the person will likely provide that same response, without giving the problem too much thought, even though a more appropriate response might be available. Essentially, the Einstellung effect is one of the human brain's ways of finding an appropriate solution/behavior as efficiently as possible. Note, however, that although finding the solution is efficient, the solution found might not necessarily be the *most* appropriate solution.

Luchins and Luchins water jar experiment

The water jar test, first described in Abraham Luchins 1942 classic experiment,[1] is a commonly cited example of an Einstellung situation. The experiment's participants were given the following problem: you have 3 water jars, each with the capacity to hold a different, fixed amount of water; figure out how to measure a certain amount of water using these jars. It was found that subjects used methods that they had used previously to find the solution even though there were quicker and more efficient methods available. The experiment shines light on how mental sets can hinder the solving of novel problems.

In Luchins experiment, subjects were divided into two groups. The experimental group was given five practice problems, followed by 4 critical test problems. The control group did not have the five practice problems. All of the practice problems and some of the critical problems had only one solution, which was "B minus A minus 2·C." For example, one is given Jar A capable of holding 21 units of water, B capable of holding 127, and C capable of holding 3. If an amount of 100 units must be measured out, the solution is to fill up Jar B and pour out enough water to fill A once and C twice.

One of the critical problems was called the extinction problem. The extinction problem was a problem that could not be solved using the previous solution $B - A - 2C$. In order to answer the extinction problem correctly, one had to solve the problem directly and generate a novel solution. An incorrect solution to the extinction problem indicated the presence of the Einstellung effect. The problems after the extinction problem again had two possible solutions. These post-extinction problems helped determine the recovery of the subjects from the Einstellung effect.

The critical problems could be solved using this solution ($B - A - 2C$) or a shorter solution ($A - C$ or $A + C$). For example, subjects were instructed to get 18 units of water from jars with capacities 15, 39, and 3. Despite the presence of a simpler solution ($A + C$), subjects in the experimental group tended to give the lengthier solution in lieu of the shorter one. Instead of

simply filling up Jars A and C, most subjects from the experimental group preferred the previous method of B − A − 2C, whereas virtually all of the control group used the simpler solution. Interestingly, when Luchins and Luchins gave experimental group subjects the warning, "Don't be blind," over half of them used the simplest solution to the remaining problems.[5] Thus, this warning helped reduce the prevalence of the Einstellung effect among the experimental group.

The results of the water jars experiment illustrates the concept of Einstellung. The majority of the experimental subjects adopted a mechanized state of mind and relied on mental sets formed through previous experience. However, the experimental subjects would have been more efficient if they had employed the direct method of solving the problem rather than applying the same solution from previous examples.

Explanations and interpretations

The Einstellung effect can be supported by theories of inductive reasoning. In a nutshell, inductive reasoning is the act of inferring a rule based on a finite number of instances. Most experiments on human inductive reasoning involve showing subjects a card with an object (or multiple objects, or letters, etc.) on it. The objects can vary in number, shape, size, color, etc., and the subject's job is to answer (initially by guessing) "yes" or "no" whether (or not) the card is a positive instance of the rule (which must be inferred by the subject). Over time, the subjects do tend to learn the rule, but the question is *how*? Kendler and Kendler (1962) [6] proposed that older children and adults tend to exhibit *noncontinuity theory*; that is, the subjects tend to pick a reasonable rule and assume it to be true until it proves false. Regarding Einstellung effect, one can view noncontinuity theory as a way of explaining the tendency to maintain a specific behavior until it fails to work. In the water-jar problem, subjects generated a specific rule because it seemed to work in all situations; when they were given problems for which the same solution worked, but a better solution was possible, they still gave their *tried and true* response. Where theories of inductive reasoning tend to diverge from the idea of Einstellung effect is when analyzing the fact that, even after an instance where the Einstellung rule failed to work, many subjects reverted to the old solution when later presented with a problem for which it did work (again, this problem also had a better solution). One way to explain this observation is that in actuality subjects know (consciously) that the same solution might not always work, yet since they were presented with so many instances where it did work, they still tend to test that solution before any other (and so if it works, it will be the first solution found).

Neurologically, the idea of synaptic plasticity, which is an important neurochemical explanation of memory, can help to understand the Einstellung effect. Specifically, Hebbian theory (which in many regards is the neuroscience equivalent of original associationist theories) is one explanation of synaptic plasticity (Hebb, 1949).[7] It states that when two associated neurons frequently fire together – while infrequently firing apart

from one another – the strength of their association tends to become stronger (making future stimulation of one neuron even more likely to stimulate the other). Since the frontal lobe is most often attributed with the roles of planning and problem solving, if there is a neurological pathway which is fundamental to the understanding of Einstellung effect, the majority of it most likely falls within the frontal lobe. Essentially, a Hebbian explanation of Einstellung could be as follows: stimuli are presented in such a way that the subject recognizes him or herself as being in a situation which he or she has been in before. That is, the subject sees, hears, smells, etc., an environment which is akin to an environment which he or she has been in before. The subject then must process the stimuli which are presented in such a way that he or she exhibits a behavior which is appropriate for the situation (be it run, throw, eat, etc.). Because neural growth is, at least in part, due to the associations between two events/ideas, it follows that the more a given stimulus is followed by a specific response, the more likely that in the future that stimulus will invoke the same response. Regarding the Luchins' experiment,[1] the stimulus presented was a water-jar problem (or to be more technical, the stimulus was a piece of paper which had words and numbers on it which, when interpreted correctly, portray a water-jar problem) and the invoked response was $B - A - 2C$. While it is a bit of a stretch to assume that there is a direct connection between a *water-jar problem* and $B - A - 2C$ within the brain, it is not unreasonable to assume that the specific neural connections which are active during a water-jar problem-state and those that are active when one thinks "take the second term, subtract the first term, then subtract two of the third term" tend to increase in the amount of overlap as more and more instances where $B - A - 2C$ works are presented.

Other Einstellung research

Psychological stress

The following experiments were designed to gauge the effect of different stressful situations on the Einstellung effect. Overall, these experiments show that stressful situations increase the prevalence of the Einstellung effect.

The speed test

Luchins gave an elementary-school class a set of water jar problems. In order to create a stressful situation, experimenters told the students that the test would be timed, that the speed and accuracy of the test would be reviewed by their principal and teachers, and that the test would affect their grades. To further agitate the students during the test, experimenters were instructed to comment on how much slower the children were compared to children in lower grades. The experimenters observed anxious, stressed, and sometimes tearful faces during the experiment.

The results of the experiment indicated that the stressful speed test situation increased rigidity. Luchins found that only three of the ninety-eight students tested were able to solve the extinction problem, and only two students used the direct method for the critical problems. The same experiment conducted under non-stress conditions showed 70% rigidity during the test problems and 58% failure of the extinction problem, while the anxiety-inducing situation showed 98% and 97% respectively.

The speed test was performed with college students as well, which yielded similar results. Even when college students were told ahead of time to use the direct method in order to avoid mistakes made by children, the college students continued to exhibit rigidity under time pressure. The results of these studies showed that the emphasis on speed increased the Einstellung

effect on the water jar problems.[8]

TOC Previous Next

Maze tracing

Luchins also instructed subjects to draw a solution through a maze without crossing any of the maze's lines. The maze was either traced normally or traced using the mirror reflection of the maze. If the subject drew over the lines of the figure, they had to start at the beginning, which was disadvantageous since the subject was told that their score depended on the time and smoothness of the solution. The mirror-tracing situation was the stressful situation, and the normal tracing was the non-stressful, control situation. Experimenters observed that the mirror-tracing task caused more drawing outside the boundaries, increased overt signs of stress and anxiety, and required more time to accurately complete. The mirror-tracing situation produced 89% Einstellung solution on the first two criticals instead of the 71% observed for normal tracing. In addition, 55% of the subjects failed with the mirror while only 18% failed without the mirror.[9]

TOC Previous Next

Hidden-word test for stutterers

In 1951, Solomon[10] gave both stutterers and fluent-speakers a hidden-word test, an arithmetical test, and a mirror-maze test. Experimenters called the hidden-word test a "speech test" to increase stutterer anxiety. There were no marked differences between the stutterers and the fluent-speakers for the arithmetical and mirror-maze tests. However, the results reveal a significant difference between the performance of the stutterers and the fluent-speakers on the "speech test." On the first two critical problems, 58 percent of the stutterers gave Einstellung solutions whereas only 4 percent of the fluent speakers showed Einstellung effects.[11]

TOC Previous Next

Age

The original Luchins and Luchins experiment tested nine-, ten-, eleven-,

and twelve-year-olds for the Einstellung effect.[1] The older groups showed more Einstellung effects than the younger groups in general. However, this initial study did not control for differences in educational level and intelligence.

To remedy this problem, Ross (1952)[12] conducted a study on middle-aged (mean 37.3 years) and older adults (mean 60.8 years). The adults were grouped according to the I.Q., years of schooling, and occupation. Ross administered five Einstellung tests including the arithmetical (water jar) test, the maze test, the hidden-word test, and two other tests. For every test, the middle-aged group performed better than the older group. For example, 65% of the older adults failed the extinction task of the arithmetical test, whereas only 29% of the middle-aged adults failed the extinction problem.

Luchins devised another experiment to determine the difference between Einstellung effects in children and in adults. In this study, 140 fifth-graders (mean 10.5 years) were compared to 79 college students (mean 21 years) and 21 adults (mean 43 years). Einstellung effects prior to the extinction task increased with age: the observed Einstellung effects for the extinction task were 56, 68, and 69 percent for young adults, children, and older adults respectively. This implies that there exists a curvilinear relationship between age and the recovery from the Einstellung Effect. A similar experiment conducted by Heglin in 1955, also found this relationship when the three age groups were equated for I.Q.

Therefore, the initial manifestation of the Einstellung effect on the arithmetic test increases with age. However, the recovery from the Einstellung effect is greatest for young adults (average age 21 years) and decreases as you move away from this age.[13]

TOC Previous Next

Gender

In Luchins and Luchins original experiment with 483 children, they found that boys demonstrated less Einstellung effects than girls.[1] The experimental difference was only significant for the group that was

instructed to write “Don’t be blind” on their papers after the sixth problem (the DBB group). “Don’t be blind” was meant as a reminder to pay attention and guard against rigidity for the sixth problem. However, this message was interpreted in many different ways including thinking of the message as just some more words to remember. The alternative interpretations occurred more frequently in girls and increased with IQ score within the female group. This difference in interpretation of DBB may account for the fact that the male DBB group showed more direct solutions than their female counterparts.

To determine sex differences in adults, Luchins gave college students the maze Einstellung test. The female group showed slightly more (although not statistically significant) Einstellung effects than the male group. Other studies have provided conflicting data about the sex differences in the Einstellung effect.[14]

TOC Previous Next

Intelligence

Luchins and Luchins looked at the relationship between the intelligence quotient (IQ) and the Einstellung effects for the children in their original experiment. They found that there was a statistically insignificant negative relationship between the Einstellung Effect and Intelligence.[15] In general, large Einstellung effects were observed for all subject groups regardless of IQ score. When Luchins and Luchins looked at the IQ range for children who did and did not demonstrate Einstellung effects, they spanned from 51 to 160 and from 75 to 155 respectively. These ranges show a slight negative correlation between intelligence and Einstellung effects.

TOC Previous Next

See also

- Beginner's mind (antonym)
- (*Einstellung effect* as a) *wrong* working hypothesis
- Functional fixedness and the candle problem
- Law of the instrument
- Missing square puzzle (a typical *Einstellung effect*)
- Thinking outside the box

Notes

1. ^ [a] [b] [c] [d] [e] Luchins 1942.
2. ^ Dronek & Blessing 2006.
3. ^ Luchins & Luchins 1959.
4. ^ Duncker 1945.
5. ^ Luchins & Luchins 1959, p. 368.
6. ^ Kendler & Kendler 1962.
7. ^ Hebb 1949.
8. ^ Luchins & Luchins 1959, pp. 120–122.
9. ^ Luchins & Luchins 1959, pp. 123–124.
10. ^ Solomon 1951.
11. ^ Luchins & Luchins 1959, p. 126.
12. ^ Ross 1952.
13. ^ Luchins & Luchins 1959, pp. 237–242.
14. ^ Luchins & Luchins 1959, pp. 246–247.
15. ^ Luchins & Luchins 1959, p. 151.

References

- *Dronek, Patrick J.; Blessing, Stephen B. (2006). "The effect of Einstellung on compositional processes" (PDF). Proceedings of the 28th Annual Conference of the Cognitive Science Society. Vancouver, British Columbia, Canada. p. 2444.*
- *Duncker, Karl (1945) [Originally published in German in 1935]. "On problem-solving". Psychological Monographs.* ***58*** *(5): i–113. doi: 10.1037/h0093599.*
- *Hebb, D.O. (1949). The organization of behavior. New York: Wiley. LCCN 49050182. OCLC 1175395.*
- *Kendler, Howard H.; Kendler, Tracy S. (1962). "Vertical and horizontal processes in problem solving". Psychological Review.* ***69*** *(1): 1–16. doi: 10.1037/h0038537.*
- *Luchins, Abraham S. (1942). "Mechanization in problem solving: The effect of Einstellung". Psychological Monographs.* ***54*** *(6): i–95. doi: 10.1037/h0093502.*
- *Luchins, Abraham S.; Luchins, Edith Hirsch (1959). Rigidity of behavior: a variational approach to the effect of Einstellung. University of Oregon Books. OCLC 14598941.*
- *Ross, V. M. (1952). "A comparison of the effect of Einstellung in different age groups".* Unpublished doctoral dissertation, McGill University.
- *Solomon, N. D. (1951). "A comparison of rigidity of behavior manifested by a group of stutterers compared with "fluent" speakers in oral and other performances as measured by the Einstellung-effect". Archived from the original on 2016-05-08.* Unpublished Master's thesis, University of Michigan.

TOC Previous

Further reading

- *Anderson, John R.; Bothell, Daniel; Byrne, Michael D.; Douglass, Scott; Lebiere, Christian; Qin, Yulin (2004). "An Integrated Theory of the Mind" (PDF). Psychological Review.* ***111*** *(4): 1036–1060. doi: 10.1037/0033-295X.111.4.1036. PMID 15482072. Archived from the original on 2015-12-01.*
- *Blessing, Stephen B.; Anderson, John R. (1996). "How people learn to skip steps" (PDF). Journal of Experimental Psychology: Learning, Memory, and Cognition.* ***22*** *(3): 576–598. doi: 10.1037/0278-7393.22.3.576. Archived from the original on 2016-05-08.*
- *Luchins, A. S.; Luchins, E. H. (1987). "Einstellung Effects" (PDF). Science.* ***238*** *(4827): 598. doi: 10.1126/science.238.4827.598-b. Archived from the original on 2015-10-14.*
- *Taatgen, Niels A.; Lee, Frank J. (2003). "Production Compilation: A Simple Mechanism to Model Complex Skill Acquisition" (PDF). Human Factors: The Journal of the Human Factors and Ergonomics Society.* ***45*** *(1): 61–76. doi: 10.1518/hfes.45.1.61.27224. Archived from the original on 2016-05-08.*

Categories:

- Problem solving
- Cognitive science

This page was last edited on 4 December 2017, at 03:34.

Back to main TOC

Contents

Intentional Stance

The **intentional stance** is a term coined by philosopher Daniel Dennett for the level of abstraction in which we view the behavior of an entity in terms of mental properties. It is part of a theory of mental content proposed by Dennett, which provides the underpinnings of his later works on free will, consciousness, folk psychology, and evolution.

Dennett and intentionality

Dennett (1971, p. 87) states that he took the concept of " intentionality" from the work of the German philosopher Franz Brentano.[1] When clarifying the distinction between mental phenomena (viz., mental activity) and physical phenomena, Brentano (p. 97) argued that, in contrast with physical phenomena,[2] the "distinguishing characteristic of all mental phenomena"[3] was "the reference to something as an object" – a characteristic he called "*intentional inexistence*".[4] Dennett constantly speaks of the " *aboutness*" of *intentionality*; for example: "the aboutness of the pencil marks composing a shopping list is derived from the intentions of the person whose list it is" (Dennett, 1995, p. 240).

John Searle (1999, pp. 85) stresses that "competence" in predicting/explaining human behaviour involves being able to both recognize others as "*intentional*" beings, and interpret others' minds as having "intentional states" (e.g., beliefs and desires):

> "The primary evolutionary role of the mind is to relate us in certain ways to the environment, and especially to other people. My subjective states relate me to the rest of the world, and the general name of that relationship is "intentionality." These subjective states include beliefs and desires, intentions and perceptions, as well as loves and hates, fears and hopes. "Intentionality," to repeat, is the general term for all the various forms by which the mind can be directed at, or be about, or of, objects and states of affairs in the world." (p.85)[5]

According to Dennett (1987, pp. 48–49), folk psychology provides a systematic, "reason-giving explanation" for a particular action, and an account of the historical origins of that action, based on deeply embedded assumptions about the agent;[6] namely that:

(a) the agent's action was entirely rational;[7]
(b) the agent's action was entirely reasonable (in the prevailing

circumstances);
(c) the agent held certain *beliefs*;[8]
(d) the agent *desired* certain things; and
(e) the agent's future action could be systematically predicted from the *beliefs* and *desires* so ascribed.

This approach is also consistent with the earlier work of Fritz Heider and Marianne Simmel, whose joint study revealed that, when subjects were presented with an animated display of 2-dimensional shapes, they were inclined to ascribe intentions to the shapes.[9]

Further, Dennett (1987, p. 52) argues that, based on our fixed personal views of what all humans ought to believe, desire and do, we predict (or explain) the beliefs, desires and actions of others "by calculating in a normative system";[10] and, driven by the reasonable assumption that all humans are rational beings – who do *have* specific beliefs and desires and do *act* on the basis of those beliefs and desires in order to get what they want – these predictions/explanations are based on four simple rules:

1. The agent's *beliefs* are those a rational individual ought to have (i.e., given their "perceptual capacities", "epistemic needs" and "biography");[11]
2. In general, these beliefs "are both true and relevant to [their] life;[12]
3. The agent's *desires* are those a rational individual ought to have (i.e., given their "biological needs", and "the most practicable means of satisfying them") in order to further their "survival" and "procreation" needs;[13] and
4. The agent's behaviour will be composed of those acts a rational individual holding those *beliefs* (and having those *desires*) ought to perform.

Dennett's three levels

The core idea is that, when understanding, explaining, and/or predicting the behavior of an object, we can choose to view it at varying levels of abstraction. The more concrete the level, the more accurate *in principle* our predictions are; the more abstract, the greater the computational power we gain by zooming out and skipping over the irrelevant details.

Dennett defines three levels of abstraction, attained by adopting one of three entirely different "stances", or intellectual strategies: the physical stance; the design stance; and the intentional stance:[14]

- The most concrete is the *physical stance*, the domain of physics and chemistry, which makes predictions from knowledge of the physical constitution of the system and the physical laws that govern its operation; and thus, given a particular set of physical laws and initial conditions, and a particular configuration, a specific future state is predicted (this could also be called the "*structure stance*").[15] At this level, we are concerned with such things as mass, energy, velocity, and chemical composition. When we predict where a ball is going to land based on its current trajectory, we are taking the physical stance. Another example of this stance comes when we look at a strip made up of two types of metal bonded together and predict how it will bend as the temperature changes, based on the physical properties of the two metals.
- Somewhat more abstract is the *design stance*, the domain of biology and engineering, which requires no knowledge of the physical constitution or the physical laws that govern a system's operation. Based on an implicit assumption that there is no malfunction in the system, predictions are made from knowledge of the purpose of the system's design (this could also be called the "*teleological stance*").[16] At this level, we are concerned with such things as purpose, function and design. When we predict that a bird will fly when it flaps its wings on the basis that wings are made for flying, we are taking the design stance. Likewise, we can understand the bimetallic strip as a particular type of thermometer, not concerning ourselves with the

details of how this type of thermometer happens to work. We can also recognize the purpose that this thermometer serves inside a thermostat and even generalize to other kinds of thermostats that might use a different sort of thermometer. We can even explain the thermostat in terms of what it's good for, saying that it keeps track of the temperature and turns on the heater whenever it gets below a minimum, turning it off once it reaches a maximum.

- Most abstract is the *intentional stance*, the domain of software and minds, which requires no knowledge of either structure or design,[17] and "[clarifies] the logic of mentalistic explanations of behaviour, their predictive power, and their relation to other forms of explanation" (Bolton & Hill, 1996, p. 24). Predictions are made on the basis of *explanations* expressed in terms of meaningful mental states; and, given the task of predicting or explaining the behaviour of a specific agent (a person, animal, corporation, artifact, nation, etc.), it is implicitly assumed that the agent will always act on the basis of its *beliefs* and *desires* in order to get precisely what it wants (this could also be called the "*folk psychology stance*").[18] At this level, we are concerned with such things as belief, thinking and intent. When we predict that the bird will fly away because it knows the cat is coming and is afraid of getting eaten, we are taking the intentional stance. Another example would be when we predict that Mary will leave the theater and drive to the restaurant because she sees that the movie is over and is hungry.
- In 1971, Dennett also postulated that, whilst "the intentional stance *presupposes* neither lower stance", there may well be a fourth, higher level: a "truly moral stance toward the system" – the "*personal stance*" – which not only "presupposes the intentional stance" (viz., treats the system as *rational*) but also "views it as a person" (1971/1978, p. 240).

A key point is that switching to a higher level of abstraction has its risks as well as its benefits. For example, when we view both a bimetallic strip and a tube of mercury as thermometers, we can lose track of the fact that they differ in accuracy and temperature range, leading to false predictions as soon as the thermometer is used outside the circumstances for which it was designed. The actions of a mercury thermometer heated to 500 °C can no

longer be predicted on the basis of treating it as a thermometer; we have to sink down to the physical stance to understand it as a melted and boiled piece of junk. For that matter, the "actions" of a dead bird are not predictable in terms of beliefs or desires.

Even when there is no immediate error, a higher-level stance can simply fail to be useful. If we were to try to understand the thermostat at the level of the intentional stance, ascribing to it beliefs about how hot it is and a desire to keep the temperature just right, we would gain no traction over the problem as compared to staying at the design stance, but we would generate theoretical commitments that expose us to absurdities, such as the possibility of the thermostat not being in the mood to work today because the weather is so nice. Whether to take a particular stance, then, is determined by how successful that stance is when applied.

Dennett argues that it is best to understand human behavior at the level of the intentional stance, without making any specific commitments to any deeper reality of the artifacts of folk psychology. In addition to the controversy inherent in this, there is also some dispute about the extent to which Dennett is committing to realism about mental properties. Initially, Dennett's interpretation was seen as leaning more towards instrumentalism,[19] but over the years, as this idea has been used to support more extensive theories of consciousness, it has been taken as being more like Realism. His own words hint at something in the middle, as he suggests that the self is as real as a center of gravity, "an abstract object, a theorist's fiction", but operationally valid.[20]

As a way of thinking about things, Dennett's intentional stance is entirely consistent with everyday commonsense understanding; and, thus, it meets Eleanor Rosch's (1978, p. 28) criterion of the "maximum information with the least cognitive effort". Rosch argues that, implicit within any system of categorization, are the assumptions that:

> (a) the major purpose of any system of categorization is to reduce the randomness of the universe by providing "maximum information with the least cognitive effort", and
> (b) the real world is structured and systematic, rather than being

> arbitrary or unpredictable. Thus, if a particular way of categorizing information does, indeed, "provide maximum information with the least cognitive effort", *it can only do so because the structure of that particular system of categories corresponds with the perceived structure of the real world*.

Also, the intentional stance meets the criteria Dennett specified (1995, pp. 50–51) for algorithms:

> (1) *Substrate Neutrality*: It is a "mechanism" that produces results regardless of the material used to perform the procedure ("the power of the procedure is due to its logical structure, not the causal powers of the materials used in the instantiation").
> (2) *Underlying Mindlessness*: Each constituent step, and each transition between each step, is so utterly simple, that they can be performed by a "dutiful idiot".
> (3) *Guaranteed Results*: "Whatever it is that an algorithm does, it always does it, if it is executed without misstep. An algorithm is a foolproof recipe."

Variants of Dennett's three stances

The general notion of a three level system was widespread in the late 1970s/early 1980s; for example, when discussing the mental representation of information from a cognitive psychology perspective, Glass and his colleagues (1979, p. 24) distinguished three important aspects of representation:

> (a) the *content* ("what is being represented");
> (b) the *code* ("the format of the representation");[21] and
> (c) the *medium* ("the physical realization of the code").[22]

Other significant cognitive scientists who also advocated a three level system were Allen Newell, Zenon Pylyshyn, and David Marr. The parallels between the four representations (each of which implicitly assumed that computers *and* human minds displayed each of the three distinct levels) are detailed in the following table:

TOC | Previous | Next

Objections and replies

The most obvious objection to Dennett is the intuition that it "matters" to us whether an object has an inner life or not. The claim is that we don't just imagine the intentional states of other people in order to predict their behaviour; the fact that they have thoughts and feelings just like we do is central to notions such as trust, friendship and love. The Blockhead argument proposes that someone, Jones, has a twin who is in fact not a person but a very sophisticated robot which looks and acts like Jones in every way, but who (it is claimed) somehow does not have any thoughts or feelings at all, just a chip which controls his behaviour; in other words, "the lights are on but no one's home". According to the intentional systems theory (IST), Jones and the robot have precisely the same beliefs and desires, but this is claimed to be false. The IST expert assigns the same mental states to Blockhead as he does to Jones, "whereas in fact [Blockhead] has not a thought in his head." Dennett has argued against this by denying the premise, on the basis that the robot is a philosophical zombie and therefore metaphysically impossible. In other words, if something acts in all ways conscious, it necessarily is, as consciousness is defined in terms of behavioral capacity, not ineffable qualia.[37]

Another objection attacks the premise that treating people as ideally rational creatures will yield the best predictions. Stephen Stich argues that people often have beliefs or desires which are irrational or bizarre, and IST doesn't allow us to say anything about these. If the person's "environmental niche" is examined closely enough, and the possibility of malfunction in their brain (which might affect their reasoning capacities) is looked into, it may be possible to formulate a predictive strategy specific to that person. Indeed this is what we often do when someone is behaving unpredictably — we look for the reasons why. In other words, we can only deal with irrationality by contrasting it against the background assumption of rationality. This development significantly undermines the claims of the intentional stance argument.

The rationale behind the intentional stance is based on evolutionary theory, particularly the notion that the ability to make quick predictions of a

system's behaviour based on what we think it might be thinking was an evolutionary adaptive advantage. The fact that our predictive powers are not perfect is a further result of the advantages sometimes accrued by acting contrary to expectations.

Neural evidence

Philip Robbins and Anthony I. Jack suggest that "Dennett's philosophical distinction between the physical and intentional stances has a lot going for it" from the perspective of psychology and neuroscience. They review studies on abilities to adopt an intentional stance (variously called "mindreading," "mentalizing," or "theory of mind") as distinct from adopting a physical stance ("folk physics," "intuitive physics," or "theory of body"). Autism seems to be a deficit in the intentional stance with preservation of the physical stance, while Williams syndrome can involve deficits in the physical stance with preservation of the intentional stance. This tentatively suggests a double dissociation of intentional and physical stances in the brain.[38] However, most studies have found no evidence of impairment in autistic individuals' ability to understand other people's basic intentions or goals; instead, data suggests that impairments are found in understanding more complex social emotions or in considering others' viewpoints.[39]

Robbins and Jack point to a 2003 study[40] in which participants viewed animated geometric shapes in different "vignettes," some of which could be interpreted as constituting social interaction, while others suggested mechanical behavior. Viewing social interactions elicited activity in brain regions associated with identifying faces and biological objects (posterior temporal cortex), as well as emotion processing (right amygdala and ventromedial prefrontal cortex). Meanwhile, the mechanical interactions activated regions related to identifying objects like tools that can be manipulated (posterior temporal lobe). The authors suggest "that these findings reveal putative 'core systems' for social and mechanical understanding that are divisible into constituent parts or elements with distinct processing and storage capabilities."[40]

TOC Previous Next

Phenomenal stance

Robbins and Jack argue for an additional stance beyond the three that Dennett outlined. They call it the *phenomenal stance*: Attributing consciousness, emotions, and inner experience to a mind. The explanatory gap of the hard problem of consciousness illustrates this tendency of people to see phenomenal experience as different from physical processes. The authors suggest that psychopathy may represent a deficit in the phenomenal but not intentional stance, while people with autism appear to have intact moral sensibilities, just not mind-reading abilities. These examples suggest a double dissociation between the intentional and phenomenal stances.[38][41]

In a follow-up paper, Robbins and Jack describe four experiments about how the intentional and phenomenal stances relate to feelings of moral concern. The first two experiments showed that talking about lobsters as strongly emotional led to a much greater sentiment that lobsters deserved welfare protections than did talking about lobsters as highly intelligent. The third and fourth studies found that perceiving an agent as vulnerable led to greater attributions of phenomenal experience. Also, people who scored higher on the empathetic-concern subscale of the Interpersonal Reactivity Index had generally higher absolute attributions of mental experience.[42]

Bryce Huebner (2010) performed two experimental philosophy studies to test students' ascriptions of various mental states to humans compared with cyborgs and robots. Experiment 1 showed that while students attributed both beliefs and pains most strongly to humans, they were more willing to attribute beliefs than pains to robots and cyborgs.[43]:138 "[T]hese data seem to confirm that commonsense psychology does draw a distinction between phenomenal and non-phenomenal states--and this distinction seems to be dependent on the structural properties of an entity in a way that ascriptions of non-phenomenal states are not."[43]:138–39 However, this conclusion is only tentative in view of the high variance among participants.[43]:139 Experiment 2 showed analogous results: Both

beliefs and happiness were ascribed most strongly to biological humans, and ascriptions of happiness to robots or cyborgs were less common than ascriptions of beliefs.[43]:142

See also

Footnotes

1. ^ In his second edition (1973/1924, pp. 180–81), Brentano added this explanation of "intentional" to his 1911 edition: "This expression had been misunderstood in that some people thought it had to do with intention and the pursuit of a goal. In view of this, I might have done better to avoid it altogether. Instead of the term 'intentional' the Scholastics very frequently used the expression 'objective'. This has to do with the fact that something is an object for the mentally active subject, and, as such, is present in some manner in his consciousness, whether it is merely thought of or also desired, shunned, etc. I preferred the expression 'intentional' because I thought there would be an even greater danger of being misunderstood if I had described the object of thought as 'objectively existing', for modern day thinkers use this expression to refer to what really exists as opposed to 'mere subjective appearances'."
2. ^ In addition to cogitations (such as judgement, recollection and inference) and emotions (such as joy and sorrow and fear), Brentano (op.cit. p. 79) includes things such as "hearing a sound, seeing a colored object, feeling warm or cold" in his category of physical phenomena.
3. ^ By contrast, Brentano (p. 80) includes things such as "a color... a chord which I hear, warmth, cold, odor which I sense" in his category of mental phenomena.
4. ^ Note that, whilst the term "inexistence" appears haphazardly right throughout the text of Bretano's work as both ***in-existence*** and '***inexistence***, it very clearly always carries the "inherence" meaning (i.e., the fact or condition of existing in something), rather than the "non-existence" meaning (i.e., the fact or condition of not existing).
5. ^ Searle (1999, pp. 85–86) clarifies his usage: "***Intentionality*** is an unfortunate word, and like a lot of unfortunate words in philosophy, we owe it to the German-speaking philosophers. The word suggests that intentionality, in the sense of directedness, must always have some connection with 'intending' in the sense in which, for example, I intend to go to the movies tonight. (German has no problem with this because ***Intentionalität'*** does not sound like ***Absicht'***, the word for

intention in the ordinary sense of intending to go to the movies.) So we have to keep in mind that in English intending is just one form of intentionality among many.
Foss and Bow (1986, p. 94) present a far more A.I.-oriented view: "We assume that people understand the actions of others by viewing those actions as purposive, as goal directed. People use their knowledge of human intentionality, of the types of goals people have and of the types of plans they devise in service of those goals, to understand action sequences that are described in narratives or observed directly. Many recent approaches to comprehension emphasize the role of goal planning knowledge when understanding narratives and conversations, and when remembering observed sequences and goal directed actions. According to these approaches, understanding involves inferring the intentions (i.e. the plans and goals) of the characters, speakers, or actors. Such inferences are ubiquitous because narratives frequently provide only sketchy descriptions of the character's actions and goals; speakers rarely state their intentions directly; and observers rarely see all the events preceding or following the action to be explained. Therefore, people are forced to use their general knowledge of human intentionality to fill in the missing information; they do this by generating expectations and drawing inferences in order to come up with a plan that explains an actor's behavior. Although the importance of this type of knowledge for understanding natural discourse and action sequences has been recognized, only recently have cognitive scientists begun examining the psychological processes involved in drawing inferences about human intentionality..."

6. ^ Because we use folk psychology effortlessly all the time to *systematically predict* actions, and because this way of thinking about things seems to be so very effective – Fodor (1987, p. 3) speaks of its "extraordinary predictive power" – Dennett is certain that the practice of treating others as rational agents must have evolved and developed over time: "we treat each other as if we were rational agents, and this myth – for surely we are not all that rational – works very well because we are pretty rational" (p. 50). Siegert (2001, p. 183), agrees: "Evolutionary psychology argues that the ability to form a representation of what another human is thinking is an ability that has

been acquired and developed through natural selection. The ability to interpret other people's facial expressions, their body language, and their tone of voice, has obvious advantages for survival. In earlier environments, our ancestors had to be able determine who was a friend and who was an enemy, who was a potential mate and who was not. The ability to distinguish between facial expressions associated with suspicion and curiosity, fear and anger, or disgust and sadness, may have been the difference between life and death. In modern society we also rely on this ability for surviving socially, if not literally. Our ability to accurately express our emotions, to know how and when to express them, to know when to conceal our emotions, and to be able read and interpret the emotions of other people are skills that impact hugely on our ability to form lasting relationships, breed and raise healthy children, and gain high status in our careers" (p. 183).

7. ^ Dennett stresses how research into artificial intelligence has shown just how rational humans actually are: "Even the most sophisticated AI programs stumble blindly into misinterpretations and misunderstandings that even small children reliably evade without a second thought" (1987, p. 52).
8. ^ Note that it is irrelevant whether the agent actually holds these particular beliefs or not; the critical feature is that the observer ascribes them to the agent. The intentional stance involves an observer amassing a constellation of subjective, observer-centred assumptions, unique to that specific observer, that are expressed in the form of a set of supposed beliefs and desires which are attributed to (and projected upon) the object of that observation *in order to explain something to the observer*. The observer is not trying to objectively determine the agent's actual state of mind. His only need is to be able to represent the agent's behaviour to himself in such a way that he can respond to the agent's behaviour. Consequently, these attributions rarely describe any actual belief or desire an agent might maintain at any time; and the objective truth of the observer's subjective assumptions about the agent's "inner life" is entirely irrelevant – always provided, of course, that his response to the agent's behaviour has been appropriate.
9. ^ See Heider & Simmel (1944); the animation used in the experiment

is at "youtube.com/watch?v=n9TWwG4SFWQ".

10. ^ In other words, humans have a propensity to systematically think as follows: **X** has performed action **A** because they believe **B**, and desires **D**, and (on the basis of their desire for **D**, and their belief that **B** is how things obtain in the real world) **X** has chosen to **A**, with the intention of achieving goal **G** (which, as they understand things, will produce outcome **D**). This deep desire to eschew disorder and make things systematic has a parallel in the way that humans assess the concept of "randomness". In many circumstances, according to Falk and Konold (1997; 1998), an individual's concept of what is "random" is, in fact, far from it – and this "*subjective randomness*" is, often, far more disordered than a truly random sequence. Lisanby and Lockhead (1991), also differentiate between subjective randomness and genuine randomness (upon which they which they bestow the tautologous title of "*stochastic randomness*").

    > "That subjective randomness results from people's failure to make sense of their observations is not a new idea. Piaget and Inhelder [viz., 1951/1975] attribute the origin of the idea of chance in children to their realizing the impossibility of predicting oncoming events or finding causal explanations. The experience of randomness is thus construed as an admission of failure of our intellectual operations" (Falk and Konold, 1988, p. 658).

11. ^ Swinburne (2001, pp. 39–40) argues that one of the most important features of beliefs is that they are involuntary: "Belief is a passive state; believing is a state in which you are, it is not a matter of you doing something. And it is an involuntary state, a state in which you find yourself and which you cannot change at will at an instant. I believe that today is Tuesday, that I am now in Oxford, that Aquinas died in AD 1274, and so on and so on. I cannot sudden-ly decide to believe that today is Monday, that I am now in Italy, or that Aquinas lived in the eighteenth century. That belief is involuntary was a claim of Locke, Leibniz, and Hume. "Belief consists", wrote Hume, "merely in a certain feeling or sentiment; in something that depends not on the will, but must arise from certain determinate causes and principles of which we are not masters."
12. ^ In addressing cases where an agent's beliefs are not "both true and

relevant to [their] life", Dennett (1987, p. 49) notes that "when false beliefs are attributed, special stories must be told to explain how the error resulted from the presence of features in the environment that are deceptive relative to the perceptual capacities of the system."

13. ^ Dennett also addresses the cases in which the desires are "abnormal" and remarks that "[these] 'abnormal' desires are attributable if special stories can be told" (1987, p. 49).
14. ^ Dennett, D. C., (1987) "Three Kinds of Intentional Psychology", pp. 43–68 in Dennett, D. C., *The Intentional Stance*, The MIT Press, (Cambridge), 1987.
15. ^ Perkins (1983, p. 360), refers to the results of this "***machine style***" of perception as a "***physicist's system***".
16. ^ Like Rudyard Kipling's *Just So Stories*, the theme of the "design" category is that things are simply just that way: a parallel to the doctoral candidate in Molière's *Le Malade imaginaire*, who, when asked why opium made people go to sleep, spoke of it having a "dormitive virtue" (a sleep-inducing factor): "If you know something about the design of an artifact, you can predict its behavior without worrying yourself about the underlying physics of its parts. Even small children can readily learn to manipulate such complicated objects as VCRs without having a clue how they work; they know just what will happen when they press a sequence of buttons, because they know what is designed to happen. They are operating from what I call the design stance" (Dennett, 1995, p. 229).
17. ^ Perkins (1983, p. 360), refers to the results of this "***human style***" of perception as a "***pragmatist's system***".
18. ^ Observing that the term "belief" has a very wide range of meanings – and remarking that "we seldom talk about what people *believe*, we [usually] talk about what they *think* and what they *know*" – Dennett (1987, p. 46) produces a precise definition: "folk psychology has it that ***beliefs*** are information-bearing states of people that arise from perceptions and that, together appropriately related ***desires***, lead to intelligent ***action***".
19. ^ Papineau (1995) defines instrumentalism as: "The doctrine that scientific theories are not true descriptions of an unobservable reality, but merely useful instruments which enable us to order and anticipate the observable world": a parallel to Perkins' "pragmatist's system"

(Perkins, 1983, p. 360).

20. ^ *Daniel Dennett. "The Self as a Center of Narrative Gravity". Retrieved 2008-07-03.*
21. ^ Glass et al. (1979, p. 3) distinguish between *content* and *code* as follows: "A simple English word like ***cat*** is a representation. It represents a certain ***concept*** or idea, namely the concept of a furry house-hold pet that purrs. Note that this same concept can be represented in many different ways. We could use a picture of a cat to represent the concept. We could translate cat into Spanish and represent it by ***gato***. We could represent it in Morse code by a series of dots and dashes, or in Braille by a certain tactile pattern. Across all these examples the information being represented stays the same. This common information is called the content of the representation. Each different way the information can be expressed is called a representational code. So the words ***cat*** and ***gato*** represent the same content, but in different codes (i.e., written English vs. written Spanish). In contrast the words ***cat*** and ***lawyer*** represent different contents, but in the same code (written English)."
22. ^ Glass et al. (1979, p. 3) distinguish between *code* and *media* as follows: "Listen to someone singing. Then listen to a recording of the same person singing the same song. The two sounds would probably be virtually identical. Yet the sound would be produced in very different ways – in one case by human vocal cords, in the other by electronic components. These are two different ***media*** for producing the same auditory ***code***." Glass et al. also make the point that "cognitive psychology primarily explores representational codes" (p. 24) and "cognitive psychologists study representational codes rather than media" (p. 7).
23. ^ In the case of both Dennett and Pylyshyn's terminology the designation "physical" means "relating to physics" (as in "physical laws"), with the strong implication that we are speaking of "hard science".
24. ^ "The structure and the principles by which the physical object functions correspond to the physical or the biological level" (Pylyshyn, 1989, p. 57). "We obviously need the biological level to explain such things as the effects of drugs or jet lag or brain damage on behavior" (p.6 1).

25. ^ Essentially the same as Pylyshyn's *Physical Level or Biological Level*.
26. ^ Specifies the algorithm's physical substrates (Marr, 1982, p. 24): "How can the representation and algorithm be realized physically?" (p. 25).
27. ^ In "Brain Writing and Mind Reading" (1975), Dennett very clearly states that he is agnostic about what he terms "Brain Writing".
28. ^ "The semantic content of knowledge and goals is assumed to be encoded by symbolic expressions" (Pylyshyn, 1989, p. 57). "We need the symbol level to explain such things as why some tasks take longer or result in more errors than other tasks" (p. 60). "Information processing psychology is full of examples of discovering that the form of the representation makes a difference to their [sic] behavior in experiments. For example, in problem-solving experiments it makes a difference whether subjects encode the fact that all the objects in a box are red or the equivalent fact that none of the objects is blue" (p. 61).
29. ^ Essentially the same as Pylyshyn's *Symbol Level*.
30. ^ Specifies how the device does what it does (Marr, 1982, p. 23): "How can this computational theory be implemented? In particular, what is the representation for the input and output, and what is the algorithm for the transformation?" (p. 25).
31. ^ Dennett stressed "that the intentional stance presupposes ***neither*** lower stance" (Dennett 1971/1978, p. 240)
32. ^ : "Although the cognitive science community tends to use the term knowledge quite freely in discussing semantic level principles, it is sometimes worth distinguishing those semantic entities that are knowledge from those that are goals, percepts, plans, and so on. The more general term semantic level is used in contexts where such distinctions are important. Philosophers even talk about the 'intentional' level or 'intentional' objects, but because the use of that terminology tends to raise a large, ancient, and not entirely relevant set of issues, we [viz., Pylyshyn and Newell] shun that term here" (Pylyshyn, 1989, p. 86).
33. ^ Pylyshyn (1989): "[Explains] why people, or appropriately programmed computers, do certain things by saying what they know and what their goals are and by showing that these are connected in

certain meaningful or even rational ways." (p. 57) "We need the knowledge level to explain why certain goals and beliefs tend to lead to certain behaviors, and why the behaviors can be changed in rational ways when new beliefs are added by telling things." (p. 60)

34. ^ Newell was aware of Dennett's views prior to Newell's (1980) address that was, later, published in full 1982: "Before I finished preparing that address I found and read *Brainstorms*. It was instantly clear to me that the knowledge level and the intentional stance are fundamentally the same, and I indicated as much in the talk." (Newell, 1988, p. 521)
35. ^ Newell (1982), p. 98: "The system at the knowledge level is the agent. The components at the knowledge level are ***goals***, ***actions***, and ***bodies***. Thus, an agent is composed of a set of actions, a set of goals and a body. The medium at the knowledge level is ***knowledge*** (as might be suspected). Thus, the agent processes its knowledge to determine the actions to take. Finally, the behavior law is the ***principle of rationality***: Actions are selected to attain the agent's goals.
"To treat a system at the knowledge level is to treat it as having some knowledge and some goals, and believing it will do whatever is within its power to attain its goals, in so far as its knowledge indicates."
36. ^ This level specifies "***what*** the device does and why" (Marr, 1982, p. 22): "What is the goal of the computation, why is it appropriate, and what is the logic of the strategy by which it can be carried out?" (p. 25)
37. ^ Daniel Dennett, The Unimagined Preposterousness of Zombies
38. ^ *a* *b* *Philip Robbins; Anthony I. Jack (Jan 2006). "The phenomenal stance". Philosophical Studies.* ***127*** *(1): 59–85. doi:10.1007/s11098-005-1730-x.*
39. ^ *Hamilton AF (2009). "Goals, intentions and mental states: challenges for theories of autism". J Child Psychol Psychiatry.* ***50*** *(8): 881–92. CiteSeerX 10.1.1.621.6275 . doi:10.1111/j.1469-7610.2009.02098.x. PMID 19508497.*
40. ^ *a* *b* *Alex Martin; Jill Weisberg (2003). "Neural Foundations For Understanding Social And Mechanical Concepts". Cogn Neuropsychol.* ***20*** *(3-6): 575–87. doi:10.1080/02643290342000005.*

PMC 1450338 . PMID 16648880.

41. ^ *Anthony I. Jack; Philip Robbins (Sep 2006). "The Phenomenal Stance". Philosophical Studies (127): 59–85. doi:10.1007/s11098-005-1730-x.*
42. ^ *Anthony I. Jack; Philip Robbins (Sep 2012). "The Phenomenal Stance Revisited" (PDF). Review of Philosophy and Psychology.* ***3*** *(3): 383–403. doi:10.1007/s13164-012-0104-5.*
43. ^ [a] [b] [c] [d] *Bryce Huebner (Mar 2010). "Commonsense concepts of phenomenal consciousness: Does anyone care about functional zombies?" (PDF). Phenomenology and the Cognitive Sciences.* ***9*** *(1): 133–55. doi:10.1007/s11097-009-9126-6.*

References

- Braddon-Mitchell, D., & Jackson, F. *Philosophy of Mind and Cognition*, Basil Blackwell, Oxford, 1996
- Bolton, D. & Hill, J., *Mind, Meaning, and Mental Disorder: The Nature of Causal Explanation in Psychology and Psychiatry*, Oxford University Press, (Oxford), 1996.
- Brentano, F., (1973/1924) *Psychology from an Empirical Standpoint (Second Edition)*, Routledge & Kegan Paul, (London) 1973 (The German version of the Second Edition was published in 1924).
- Dennett, D.C., (1971) "Intentional Systems", *The Journal of Philosophy*, Vol.68, No. 4, (25 February 1971), pp.87-106.
- Dennett, D.C., (1971/1978) "Mechanism and Responsibility", reprinted in pp. 233–255 in Dennett, D.C., *Brainstorms: Philosophical Essays on Mind and Psychology*, Bradford Books, (Montgomery), 1978 (originally published in 1971).
- Dennett, D.C., (1975) "Brain Writing and Mind Reading", *Minnesota Studies in the Philosophy of Science*, 7: 403-415.
- Dennett, D., (1987) "True Believers" in Dennett, D. *The Intentional Stance*, The MIT Press, Cambridge, Mass., 1987
- Daniel C. Dennett (1996), *The Intentional Stance (6th printing)*, Cambridge, Massachusetts: The MIT Press, ISBN 0-262-54053-3 (First published 1987).
- Dennett, D.C., (1995) *Darwin's Dangerous Idea: Evolution and the Meanings of Life*, Simon & Schuster, (New York), 1995.
- Daniel C. Dennett (1997), "Chapter 3. True Believers: The Intentional Strategy and Why it Works", in John Haugeland, *Mind Design II: Philosophy, Psychology, Artificial Intelligence*. Massachusetts: Massachusetts Institute of Technology. ISBN 0-262-08259-4 (first published in *Scientific Explanation*, 1981, edited by A.F. Heath, Oxford: Oxford University Press; originally presented as a Herbert Spencer lecture at Oxford in November 1979; also published as chapter 2 in Dennett's book *The Intentional Stance*).
- Dennett, D. "Three kinds of intentional psychology" (IP) in Heil, J. - *Philosophy of Mind: A guide and anthology*, Clarendon Press, Oxford, 2004
- Falk, R. & Konold, C., "Making Sense of Randomness: Implicit Encoding as a Basis for Judgement", *Psychological Review*, Vol.104, No.2, (April 1997), pp.301-318.
- Falk, R. & Konold, C., "Subjective Randomness", pp. 653–659, in Kotz, S., Read, C.B. & Banks, D.L., *Encyclopedia of Statistical Sciences: Update Volume 2*, John Wiley & Sons, (New York), 1988.
- Fano, Vincenzo. "Holism and the naturalization of consciousness" in *Holism*, Massimo Dell'Utri.

Quodlibet. 2002.

- Fodor, J. *Psychosemantics*, MIT Press, Cambridge, Mass., 1987.
- Foss, C.L. & Bow, G.H., "Understanding Actions in Relation to Goals", pp. 94–124 in Sharkey, N.E. (ed.), *Advances in Cognitive Science 1*, Ellis Horwood, (Chichester), 1986.
- Glass, A.L., Holyoak, K.J. & Santa, J.L., *Cognition*, Addison-Wesley Publishing Company, (Reading), 1979.
- Heider, F. & Simmel, M., "An Experimental Study of Apparent Behavior", *American Journal of Psychology*, Vol.57, (1944), pp.243-259.
- Lisanby, S.H. & Lockhead, G., "Subjective Randomness, Aesthetics, and Structure", pp. 97–114 in Lockhead, G.R. & Pomerantz, J.R. (eds.), *The Perception of Structure*, American Psychological Association, (Washington), 1991.
- Lycan, W. *Mind & Cognition*, Basil Blackwell, Oxford, 1990
- Marr, D., *Vision: A Computational Investigation into the Human Representation of Visual Information*, W.H. Freeman & Company, (New York), 1982.
- Newell, A., (1982) "The Knowledge Level", *Artificial Intelligence*, Vol.18, No.1, (January 1982), pp.87-127.
- Newell, A. (1988), "The intentional stance and the knowledge level", *Behavioral and Brain Sciences*, Vol.11, No.3, (September 1988), pp. 520–522.
- Papineau, D., "Instrumentalism", p. 410 in Honderich, T. (ed.), *The Oxford Companion to Philosophy*, Oxford University Press, (Oxford), 1995.
- Perkins, David N., "Why the Human Perceiver is a Bad Machine", pp. 341–364 in Beck, J. Hope, B. & Rosenfeld, A. (eds.), *Human and Machine Vision*, Academic Press, (New York), 1983.
- Piaget, J. & Inhelder, B. [(Leake, L., Burrell, P. & Fishbein, H.D. eds.), *The Origin of the Idea of Chance in Children*, Routledge & Kegan Paul, (London), 1975 [French original 1951].
- Pylyshyn, Z.W., "Computing in Cognitive Science", pp.51-91 in Posner, M.I.(ed.), *Foundations of Cognitive Science*, The MIT Press, (Cambridge), 1989.
- Rosch, E., "Principles of Categorization", pp. 27–48 in Rosch, E. & Lloyd, B.B. (eds), *Cognition and Categorization*, Lawrence Erlbaum Associates, Publishers, (Hillsdale), 1978.
- Searle, J., *Mind, Language and Society: Philosophy in the Real World*, Phoenix, (London), 1999.
- Siegert, R.J., "Culture, Cognition, and Schizophrenia", pp. 171–189 in Schumaker, J.F. & Ward, T. (eds.), *Cultural Cognition and Psychopathology*, Praeger, (Westport), 2001.
- Swinburne, R., *Epistemic Justification*, Oxford University Press, (Oxford), 2001.

Categories: Abstraction | Cognitive psychology | Cognitive science

| Consciousness studies | Intention | Philosophical concepts | Psycholinguistics
| Theory of mind

This page was last edited on 10 January 2018, at 19:55.

Back to main TOC

Contents

Machiavellian Intelligence

Jump to navigation Jump to search

In cognitive science and evolutionary psychology, **Machiavellian intelligence** is the capacity of an entity to be in a successful political engagement with social groups. The first introduction of this concept to primatology came from Frans de Waal's book "Chimpanzee Politics" (1982), which described social maneuvering while explicitly quoting Machiavelli. Also known as **machiavellianism**, it is the art of manipulation in which others are socially manipulated in a way that benefits the user.

TOP

TOC Next

Machiavellian behaviors

Machiavellian intelligence may be demonstrated by behaviors including:

- Blaming and forgiveness;
- Lying and truth-telling;
- Making and breaking alliances;
- Making and breaking promises;
- Making and breaking rules;
- Misleading and misdirection.

TOC Previous Next

Criticisms

Food and nutrient factors

The claim that large brains are linked to large social groups in primates and cetaceans, on which the Machiavellian intelligence hypothesis is based, is criticized by a number of researchers for overlooking the availability of food as a common limiting factor for brain size and social group size. Among primates as well as cetaceans, there are some opportunistic species that eat most types of food and other species that are specialised in particular types of food, as well as differences in the overall availability of food between different geographical regions in which the animals live. Some critics of Machiavellian intelligence argue that species that have to keep their use of nutrients down due to food poverty or specialisation in a rare type of food lowers average brain size for species that live in smaller groups, making big brains falsely appear to be linked to large groups due to the common causes of opportunistic foraging for nutritious food and a rich supply of food. These critics also cite that the "exceptions" in the form of small-brained primates in very large groups typically eat abundant but nutrient-poor foods (such as geladas that eat grass), as predicted by the food-based model, and argue that the higher individual need for nutrients put on by large brains causes groups to become smaller if the species have the same degree of digestive specialisation and environmental availability of food.[1][2]

Another criticism that relates to food regards the assumption that modern hunters and gatherers are living in marginal environments displaced by farming peoples and that people in paleolithic times supposedly lived in larger social groups than hunters and gatherers do today. The researchers who put forward that criticism cite observations that hunters and gatherers often trade with farmers who live nearby and/or steal food from them, opportunities that were not available before agriculture was invented. The critics therefore argue that our prehistoric ancestors before agriculture lived in even smaller groups than hunters and gatherers do

today, in groups smaller than those of the most opportunistic non-human apes as a result of the greater requirement for nutrients in human brains.[3][4]

Complex social groups without intelligence

Some researchers criticize the Machiavellian intelligence hypothesis from observations of social insects that form societies that are organized and yet have very small brains. Some of these insects, such as Jack jumpers and paper wasps have hierarchical societies in which each individual treat every other in accordance with their status, as opposed to the disorganized herds as which the Machiavellian intelligence hypothesis depict social animals with small brains.[5][6]

History

The term refers to Niccolò Machiavelli's *The Prince* (1513) and to the hypothesis that the techniques which lead to certain kinds of political success within large social groups are also applicable within smaller groups, including the family-unit. The term "everyday politics" was later introduced in reference to these various methods. These arguments are based on research by primatologists such as Nicholas Humphrey (1975).

See also

- Folk psychology
- Game theory
- Machiavellianism
- Iterated prisoner's dilemma

References

1. ^ Primate brain size is predicted by diet but not sociality - 2017, Alex R. DeCasien, Scott A. Williams & James P. Higham https://www.nature.com/articles/s41559-017-0112
2. ^ Evolution: Eating away at the social brain, Chris Venditti https://www.nature.com/articles/s41559-017-0122
3. ^ Hunter-Gatherers: An Interdisciplinary Perspective - 2001 edition, Catherine Panter-Brick, Robert H. Layton, Peter Rowley-Conwy
4. ^ Barely Surviving or More than Enough?: The environmental archaeology of subsistence, specialisation and surplus food production - 2013, Maaike Groot, Daphne Lentjes, Jørn Zeiler
5. ^ Ants at Work: How an Insect Society is Organized - 1999, Deborah M. Gordon
6. ^ Insects, Science & Society - 2012, David Pimentel

TOC | Previous | Next

Further reading

- Carlson, N.R., et al. (2007). Psychology: The Science of Behaviour - 4th Canadian ed.. Toronto, ON: Neil R. Carlson.
- Humphrey, N. K. (1976). The social function of the intellect. In P. P. G. Bateson & R. A. Hinde (eds.). Growing points in ethology. Cambridge: Cambridge University Press
- Byrne, R. W., & Whiten, A. (1988). Machiavellian intelligence. Oxford: Oxford University Press

TOC Previous

External links

- Michael Walzer, Political Action: The Problem of Dirty Hands (PDF), Institute for Advanced Study

Categories:

- Cognitive science
- Ethology
- Machiavellianism

This page was last edited on 30 April 2018, at 06:15.

Back to main TOC

Contents

Quantum Cognition

Jump to navigation Jump to search

Quantum cognition is an emerging field which applies the mathematical formalism of quantum theory to model cognitive phenomena such as information processing by the human brain, language, decision making, human memory, concepts and conceptual reasoning, human judgment, and perception.[1][2][3][4] The field clearly distinguishes itself from the quantum mind as it is not reliant on the hypothesis that there is something micro-physical quantum mechanical about the brain. Quantum cognition is based on the quantum-like paradigm[5][6] or generalized quantum paradigm[7] or quantum structure paradigm[8] that information processing by complex systems such as the brain, taking into account contextual dependence of information and probabilistic reasoning, can be mathematically described in the framework of quantum information and quantum probability theory.

Quantum cognition uses the mathematical formalism of quantum theory to inspire and formalize models of cognition that aim to be an advance over models based on traditional classical probability theory. The field focuses on modeling phenomena in cognitive science that have resisted traditional techniques or where traditional models seem to have reached a barrier (e.g., human memory[9]), and modeling preferences in decision theory that seem paradoxical from a traditional rational point of view (e.g., preference reversals[10]). Since the use of a quantum-theoretic framework is for modeling purposes, the identification of quantum structures in cognitive phenomena does not presuppose the existence of microscopic quantum processes in the human brain.[11]

TOP

TOC Next

Main subjects of research

TOC Next

Quantum-like models of information processing ("quantum-like brain")

The brain is definitely a macroscopic physical system operating on the scales (of time, space, temperature) which differ crucially from the corresponding quantum scales. (The macroscopic quantum physical phenomena such as e.g. the Bose-Einstein condensate are also characterized by the special conditions which are definitely not fulfilled in the brain.) In particular, the brain is simply too hot to be able perform the real quantum information processing, i.e., to use the quantum carriers of information such as photons, ions, electrons. As is commonly accepted in brain science, the basic unit of information processing is a neuron. It is clear that a neuron cannot be in the superposition of two states: firing and non-firing. Hence, it cannot produce superposition playing the basic role in the quantum information processing. Superpositions of mental states are created by complex networks of neurons (and these are classical neural networks). Quantum cognition community states that the activity of such neural networks can produce effects which are formally described as interference (of probabilities) and entanglement. In principle, the community does not try to create the concrete models of quantum (-like) representation of information in the brain.[12]

The quantum cognition project is based on the observation that various cognitive phenomena are more adequately described by quantum information theory and quantum probability than by the corresponding classical theories, see examples below. Thus the quantum formalism is considered as an operational formalism describing nonclassical processing of probabilistic data. Recent derivations of the complete quantum formalism from simple operational principles for representation of information supports the foundations of quantum cognition. The subjective probability viewpoint on quantum probability which was developed by C. Fuchs and collaborators[13] also supports the quantum cognition approach,

especially using of quantum probabilities to describe the process of decision making.

Although at the moment we cannot present the concrete neurophysiological mechanisms of creation of the quantum-like representation of information in the brain,[14] we can present general informational considerations supporting the idea that information processing in the brain matches with quantum information and probability. Here, contextuality is the key word, see the monograph of Khrennikov[1] for detailed representation of this viewpoint. Quantum mechanics is fundamentally contextual.[15] Quantum systems do not have objective properties which can be defined independently of measurement context. (As was pointed by N. Bohr, the whole experimental arrangement must be taken into account.) Contextuality implies existence of incompatible mental variables, violation of the classical law of total probability and (constructive and destructive) interference effects. Thus the quantum cognition approach can be considered as an attempt to formalize contextuality of mental processes by using the mathematical apparatus of quantum mechanics.

TOC Previous Next

Decision making

Suppose a person is given an opportunity to play two rounds of the following gamble: a coin toss will determine whether the subject wins $200 or loses $100. Suppose the subject has decided to play the first round, and does so. Some subjects are then given the result (win or lose) of the first round, while other subjects are not yet given any information about the results. The experimenter then asks whether the subject wishes to play the second round. Performing this experiment with real subjects gives the following results:

1. When subjects believe they won the first round, the majority of subjects choose to play again on the second round.
2. When subjects believe they lost the first round, the majority of subjects choose to play again on the second round.

Given these two separate choices, according to the *sure thing* principle of rational decision theory, they should also play the second round even if they don't know or think about the outcome of the first round.[16] But, experimentally, when subjects are not told the results of the first round, the majority of them decline to play a second round.[17] This finding violates the law of total probability, yet it can be explained as a quantum interference effect in a manner similar to the explanation for the results from double-slit experiment in quantum physics.[2][18][19] Similar violations of the sure-thing principle are seen in empirical studies of the Prisoner's Dilemma and have likewise been modeled in terms of quantum interference.[20]

The above deviations from classical rational expectations in agents' decisions under uncertainty produce well known paradoxes in behavioral economics, that is, the Allais, Ellsberg and Machina paradoxes.[21][22][23] These deviations can be explained if one assumes that the overall conceptual landscape influences the subject's choice in a neither predictable nor controllable way. A decision process is thus an intrinsically contextual process, hence it cannot be modeled in a single Kolmogorovian probability space, which justifies the employment of quantum probability models in decision theory. More explicitly, the paradoxical situations above can be represented in a unified Hilbert space formalism where human behavior under uncertainty is explained in terms of genuine quantum aspects, namely, superposition, interference, contextuality and incompatibility.[24][25][26][19]

Considering automated decision making, quantum decision trees have different structure compared to classical decision trees. Data can be analyzed to see if a quantum decision tree model fits the data better.[*citation needed*]

TOC Previous Next

Human probability judgments

Quantum probability provides a new way to explain human probability judgment errors including the conjunction and disjunction errors.[27] A

conjunction error occurs when a person judges the probability of a likely event L *and* an unlikely event U to be greater than the unlikely event U; a disjunction error occurs when a person judges the probability of a likely event L to be greater than the probability of the likely event L *or* an unlikely event U. Quantum probability theory is a generalization of Bayesian probability theory because it is based on a set of von Neumann axioms that relax some of the classic Kolmogorov axioms.[28] The quantum model introduces a new fundamental concept to cognition—the compatibility versus incompatibility of questions and the effect this can have on the sequential order of judgments. Quantum probability provides a simple account of conjunction and disjunction errors as well as many other findings such as order effects on probability judgments.[29][30][31]

The liar paradox - The contextual influence of a human subject on the truth behavior of a cognitive entity is explicitly exhibited by the so-called liar paradox, that is, the truth value of a sentence like "this sentence is false". One can show that the true-false state of this paradox is represented in a complex Hilbert space, while the typical oscillations between true and false are dynamically described by the Schrödinger equation.[32][33]

TOC Previous Next

Knowledge representation

Concepts are basic cognitive phenomena, which provide the content for inference, explanation, and language understanding. Cognitive psychology has researched different approaches for understanding concepts including exemplars, prototypes, and neural networks, and different fundamental problems have been identified, such as the experimentally tested non classical behavior for the conjunction and disjunction of concepts, more specifically the Pet-Fish problem or guppy effect,[34] and the overextension and underextension of typicality and membership weight for conjunction and disjunction.[35][36] By and large, quantum cognition has drawn on quantum theory in three ways to model concepts.

1. Exploit the contextuality of quantum theory to account for the contextuality of concepts in cognition and language and the phenomenon of emergent properties when concepts combine[11][37][38][39][40]
2. Use quantum entanglement to model the semantics of concept combinations in a non-decompositional way, and to account for the emergent properties/associates/inferences in relation to concept combinations[41]
3. Use quantum superposition to account for the emergence of a new concept when concepts are combined, and as a consequence put forward an explanatory model for the Pet-Fish problem situation, and the overextension and underextension of membership weights for the conjunction and disjunction of concepts.[29][37][38]

The large amount of data collected by Hampton[35][36] on the combination of two concepts can be modeled in a specific quantum-theoretic framework in Fock space where the observed deviations from classical set (fuzzy set) theory, the above-mentioned over- and under- extension of membership weights, are explained in terms of contextual interactions, superposition, interference, entanglement and emergence.[29][42][43][44] And, more, a cognitive test on a specific concept combination has been performed which directly reveals, through the violation of Bell's inequalities, quantum entanglement between the component concepts.[45][46]

TOC Previous Next

Human memory

The hypothesis that there may be something quantum-like about the human mental function was put forward with the quantum entanglement formula which attempted to model the effect that when a word's associative network is activated during study in memory experiment, it behaves like a quantum-entangled system.[9] Models of cognitive agents and memory based on quantum collectives have been proposed by Subhash Kak.[47][48] But he also points to specific problems of limits on observation and control of these memories due to fundamental logical reasons.[49]

TOC Previous Next

Semantic analysis and information retrieval

The research in (iv) had a deep impact on the understanding and initial development of a formalism to obtain semantic information when dealing with concepts, their combinations and variable contexts in a corpus of unstructured documents. This conundrum of natural language processing (NLP) and information retrieval (IR) on the web – and data bases in general – can be addressed using the mathematical formalism of quantum theory. As basic steps, (a) the seminal book "The Geometry of Information Retrieval" by K. Van Rijsbergen[50] introduced a quantum structure approach to IR, (b) Widdows and Peters utilised a quantum logical negation for a concrete search system,[40][51] and Aerts and Czachor identified quantum structure in semantic space theories, such as latent semantic analysis.[52] Since then, the employment of techniques and procedures induced from the mathematical formalisms of quantum theory – Hilbert space, quantum logic and probability, non-commutative algebras, etc. – in fields such as IR and NLP, has produced significant results.[53]

TOC Previous Next

Human perception

Bi-stable perceptual phenomena is a fascinating topic in the area of perception. If a stimulus has an ambiguous interpretation, such as a Necker cube, the interpretation tends to oscillate across time. Quantum models have been developed to predict the time period between oscillations and how these periods change with frequency of measurement.[54] Quantum theory and an appropriate model have been developed by Elio Conte to account for interference effects obtained with measurements of ambiguous figures.[55][56][57][58]

TOC Previous Next

Gestalt perception

There are apparent similarities between Gestalt perception and quantum

theory. In an article discussing the application of Gestalt to chemistry, Anton Amann writes: "Quantum mechanics does *not* explain Gestalt perception, of course, but in quantum mechanics and Gestalt psychology there exist almost isomorphic conceptions and problems:

- Similarly as with the Gestalt concept, the shape of a quantum object does *not* a priori exist but it depends on the interaction of this quantum object with the environment (for example: an observer or a measurement apparatus).
- Quantum mechanics and Gestalt perception are organized in a holistic way. Subentities do *not* necessarily exist in a distinct, individual sense.
- In quantum mechanics and Gestalt perception *objects have to be created* by elimination of holistic correlations with the 'rest of the world'."[59]

Amann comments: "The structural similarities between Gestalt perception and quantum mechanics are on a level of a parable, but even parables can teach us something, for example, that quantum mechanics is more than just production of numerical results or that the Gestalt concept is more than just a silly idea, incompatible with atomistic conceptions."[59]

Quantum-like models of cognition in economics and finance

The assumption that information processing by the agents of the market follows the laws of quantum information theory and quantum probability was actively explored by many authors, e.g., E. Haven, O. Choustova, A. Khrennikov, see the book of E. Haven and A. Khrennikov,[60] for detailed bibliography. We can mention, e.g., the Bohmian model of dynamics of prices of shares in which the quantum(-like) potential is generated by expectations of agents of the financial market and, hence, it has the mental nature. This approach can be used to model real financial data, see the book of E. Haven and A. Khrennikov (2012).

Application of theory of open quantum systems to decision making and "cell's cognition"

An isolated quantum system is an idealized theoretical entity. In reality interactions with environment have to be taken into account. This is the subject of theory of open quantum systems. Cognition is also fundamentally contextual. The brain is a kind of (self-)observer which makes context dependent decisions. Mental environment plays a crucial role in information processing. Therefore, it is natural to apply theory of open quantum systems to describe the process of decision making as the result of quantum-like dynamics of the mental state of a system interacting with an environment. The description of the process of decision making is mathematically equivalent to the description of the process of decoherence. This idea was explored in a series of works of the multidisciplinary group of researchers at Tokyo University of Science.[61][62]

Since in the quantum-like approach the formalism of quantum mechanics is considered as a purely operational formalism, it can be applied to the description of information processing by any biological system, i.e., not only by human beings.

Operationally it is very convenient to consider e.g. a cell as a kind of decision maker processing information in the quantum information framework. This idea was explored in a series of papers of the Swedish-Japanese research group using the methods of theory of open quantum systems: genes expressions were modeled as decision making in the process of interaction with environment.[63]

History

Here is a short history of applying the formalisms of quantum theory to topics in psychology. Ideas for applying quantum formalisms to cognition first appeared in the 1990s by Diederik Aerts and his collaborators Jan Broekaert, Sonja Smets and Liane Gabora, by Harald Atmanspacher, Robert Bordley, and Andrei Khrennikov. A special issue on *Quantum Cognition and Decision* appeared in the Journal of Mathematical Psychology (2009, vol 53.), which planted a flag for the field. A few books related to quantum cognition have been published including those by Khrennikov (2004, 2010), Ivancivic and Ivancivic (2010), Busemeyer and Bruza (2012), E. Conte (2012). The first Quantum Interaction workshop was held at Stanford in 2007 organized by Peter Bruza, William Lawless, C. J. van Rijsbergen, and Don Sofge as part of the 2007 AAAI Spring Symposium Series. This was followed by workshops at Oxford in 2008, Saarbrücken in 2009, at the 2010 AAAI Fall Symposium Series held in Washington, D.C., 2011 in Aberdeen, 2012 in Paris, and 2013 in Leicester. Tutorials also were presented annually beginning in 2007 until 2013 at the annual meeting of the Cognitive Science Society. A *Special Issue on Quantum models of Cognition* appeared in 2013 *Topics in Cognitive Science.*

TOC Previous Next

Related theories

It was suggested by theoretical physicists David Bohm and Basil Hiley that mind and matter both emerge from an "implicate order".[64] Bohm and Hiley's approach to mind and matter is supported by philosopher Paavo Pylkkänen.[65] Pylkkänen underlines "unpredictable, uncontrollable, indivisible and non-logical" features of conscious thought and draws parallels to a philosophical movement some call "post-phenomenology", in particular to Pauli Pylkkö's notion of the "aconceptual experience", an unstructured, unarticulated and pre-logical experience.[66]

The mathematical techniques of both Conte's group and Hiley's group involve the use of Clifford algebras. These algebras account for "non-commutativity" of thought processes (for an example, *see:* noncommutative operations in everyday life).

However, an area that needs to be investigated is the concept lateralised brain functioning. Some studies in marketing have related lateral influences on cognition and emotion in processing of attachment related stimuli.

See also

- Holonomic brain theory
- Quantum Bayesianism
- Quantum neural network
- NeuroQuantology
- Orchestrated objective reduction

TOC Previous Next

References

1. ^ a b Khrennikov, A. "Ubiquitous Quantum Structure: from Psychology to Finances". Springer, 2010.
2. ^ a b Busemeyer, J., Bruza, P. (2012), Quantum Models of Cognition and Decision, Cambridge University Press, Cambridge.
3. ^ Pothos, E. M., & Busemeyer, J. R. (2013). Can quantum probability provide a new direction for cognitive modeling. Behavioral and Brain Sciences,36,255–274.
4. ^ Wang, Z., Busemeyer, J. R., Atmanspacher, H., & Pothos, E. M. (2013). The potential of using quantum theory to build models of cognition. Topics in Cognitive Science, 5(4), 672-688.
5. ^ Khrennikov, A. 2006. Quantum-like brain: "Interference of minds" Biosystems, vol. 84, no. 3, pp. 225–241
6. ^ Khrennikov, A. Information Dynamics in Cognitive, Psychological, Social, and Anomalous Phenomena (Fundamental Theories of Physics) (Volume 138), Kluwer, 2004.
7. ^ Atmanspacher, H., Römer, H., & Walach, H. (2002). Weak quantum theory: Complementarity and entanglement in physics and beyond. Foundations of Physics, 32(3), 379–406.
8. ^ Aerts, D. & Aerts, S. (1994) Applications of quantum statistics in psychological studies of decision processes. Foundations of Science, 1, 85–97.
9. ^ a b Bruza, P., Kitto, K., Nelson, D., & McEvoy, C. (2009). Is there something quantum-like about the human mental lexicon?. *Journal of Mathematical Psychology*, 53(5), 362–377.
10. ^ Lambert Mogiliansky, A., Zamir, S., & Zwirn, H. (2009). Type indeterminacy: A model of the KT (Kahneman–Tversky)-man. Journal of Mathematical Psychology, 53(5), 349–361.
11. ^ a b de Barros, J. A., Suppes, P. (2009). Quantum mechanics, interference, and the brain. *Journal of Mathematical Psychology 53* (5), 306–313.
12. ^ Khrennikov, A. 2008. The Quantum-Like Brain on the Cognitive and Subcognitive Time Scales. Journal of Consciousness Studies, vol. 15, no.7

13. ^ Caves, C. M., Fuchs, C. A., & Schack, R. (2002). Quantum probabilities as Bayesian probabilities. Physical review A, 65(2), 022305.
14. ^ *Van den Noort, M., Lim, S., & Bosch, P. (2016). "On the need to unify neuroscience and physics". Neuroimmunology and Neuroinflammation, 3, 271–273.*
15. ^ Khrennikov, A., "Contextual Approach to Quantum Formalism" (Fundamental Theories of Physics 160), Springer, 2009.
16. ^ Savage, L. J. (1954). *The Foundations of Statistics*. John Wiley & Sons.
17. ^ Tversky, A., Shafir, E. (1992). The disjunction effect in choice under uncertainty. *Psychological Science 3*, 305–309.
18. ^ Pothos, E. M., & Busemeyer, J. R. (2009). A quantum probability explanation for violations of 'rational'decision theory. Proceedings of the Royal Society B: Biological Sciences, 276(1665), 2171–2178.
19. ^ ***a*** ***b*** Yukalov, V. I., & Sornette, D. (2011). Decision theory with prospect interference and entanglement. Theory and Decision, 70(3), 283–328.
20. ^ Musser, G. (2012). A New Enlightenment. *Scientific American* 307(5), 76–81. doi: 10.1038/scientificamerican1112-76
21. ^ Allais, M. (1953) Le comportement de l'homme rationnel devant le risque: Critique des postulats et axiomes de l'ecole Americaine. *Econometrica 21*, 503–546.
22. ^ Ellsberg, D. (1961). Risk, ambiguity, and the Savage axioms. *Quarterly Journal of Economics 75*, 643–669.
23. ^ Machina, M. J. (2009). Risk, ambiguity, and the dark-dependence axioms. *American Econonomical Review 99*, 385–392.
24. ^ Aerts, D., Sozzo, S., Tapia, J. (2012). A quantum model for the Ellsberg and Machina paradoxes. In *Quantum Interaction 2012*, Busemeyer, J., Dubois, F., Lambert-Mogilansky, A., editors, 48–59, LNCS 7620 (Springer, Berlin).
25. ^ Aerts, D., Sozzo, S., Tapia, J. (2013). Identifying quantum structures in the Ellsberg paradox. *ArXiv: 1302.3850v1 [physics.soc-ph]*.
26. ^ La Mura, P. (2009). Projective expected utility. Journal of Mathematical Psychology, 53(5), 408–414.
27. ^ Tversky, A., Kahneman, D. (1983). Extensional versus intuitive

reasoning: The conjunction fallacy in probability judgment. *Psychological Review 90*, 293–315.

28. ^ *Bond, Rachael L.; He, Yang-Hui; Ormerod, Thomas C. (2018). "A quantum framework for likelihood ratios". International Journal of Quantum Information.* ***16*** *(01): 1850002. arXiv:1508.00936 . Bibcode: 2018IJQI...1650002B. doi:10.1142/s0219749918500028. ISSN 0219-7499.*
29. ^ *a b c* Aerts D. (2009a). Quantum structure in cognition. *Journal of Mathematical Psychology 53*, 314–348.
30. ^ Busemeyer, J. R., Pothos, E., Franco, R., Trueblood, J. S. (2011). A quantum theoretical explanation for probability judgment ‘errors’. *Psychological Review 118*, 193–218.
31. ^ Trueblood, J. S., & Busemeyer, J. R. (2011). A quantum probability account of order effects in inference. Cognitive science, 35(8), 1518–1552.
32. ^ Aerts, D., Broekaert, J., Smets, S. (1999). The liar paradox in a quantum mechanical perspective. *Foundations of Science 4*, 115–132.
33. ^ Aerts, D., Aerts, S., Broekaert, J., Gabora, L. (2000). The violation of Bell inequalities in the macroworld. *Foundations of Physics 30*, 1387–1414.
34. ^ Osherson, D. N., Smith, E. E. (1981) On the adequacy of prototype theory as a theory of concepts. Cognition 9, 35–58
35. ^ *a b* Hampton, J. A. (1988a). Overextension of conjunctive concepts: Evidence for a unitary model for concept typicality and class inclusion. *Journal of Experimental Psychology: Learning, Memory, and Cognition 14*, 12–32
36. ^ *a b* Hampton, J. A. (1988b). Disjunction of natural concepts. *Memory & Cognition 16*, 579–591.
37. ^ *a b* Aerts, D., Gabora, L. (2005). A state-context-property model of concepts and their combinations I: The structure of the sets of contexts and properties. *Kybernetes 34* (1&2), 167–191.
38. ^ *a b* Aerts, D., Gabora, L. (2005). A state-context-property model of concepts and their combinations II: A Hilbert space representation. *Kybernetes 34*(1&2), 192–221.
39. ^ Gabora, L., Aerts, D. (2002). Contextualizing concepts using a mathematical generalization of the quantum formalism. *Journal of*

Experimental and Theoretical Artificial Intelligence 14 (4), 327–358.

40. ^ ***a*** ***b*** Widdows, D., Peters, S. (2003). Word Vectors and Quantum Logic: Experiments with negation and disjunction. *Eighth Mathematics of Language Conference*, 141–154.
41. ^ Bruza, P. D., Cole, R. J. (2005). Quantum logic of semantic space: An exploratory investigation of context effects in practical reasoning. In S. Artemov, H. Barringer, A. S. d'Avila Garcez, L.C. Lamb, J. Woods (eds.) *We Will Show Them: Essays in Honour of Dov Gabbay*. College Publications.
42. ^ Aerts, D. (2009b). Quantum particles as conceptual entities: A possible explanatory framework for quantum theory. *Foundations of Science 14*, 361–411.
43. ^ Aerts, D., Broekaert, J., Gabora, L., Sozzo, S. (2013). Quantum structure and human thought. *Behavioral and Brain Sciences 36* (3), 274–276.
44. ^ *Aerts, Diederik; Gabora, Liane; Sozzo, Sandro (September 2013). "Concepts and Their Dynamics: A Quantum-Theoretic Modeling of Human Thought". Topics in Cognitive Science.* ***5*** *(4): 737–772. arXiv:1206.1069 . doi:10.1111/tops.12042.*
45. ^ Aerts, D., Sozzo, S. (2012). Quantum structures in cognition: Why and how concepts are entangled. In *Quantum Interaction 2011*, Song, D., Melucci, M., Frommholz, I., editors, 118–1299, LNCS 7052 (Springer, Berlin).
46. ^ Aerts, D., Sozzo, S. (2013). Quantum entanglement in concept combinations. Accepted in *International Journal of Theoretical Physics*. *ArXiv: 1302.3831v1 [cs.Ai]*.
47. ^ Kak, S. The three languages of the brain: quantum, reorganizational, and associative. In Learning as Self-Organization, Karl Pribram and J. King (editors). Lawrence Erlbaum Associates, Mahwah, NJ, 1996, pp. 185–219.
48. ^ Kak, S. Biological memories and agents as quantum collectives. NeuroQuantology 11: 391–398, 2013.
49. ^ Kak, S. Observability and computability in physics, Quantum Matter 3: 172–176, 2014.
50. ^ Van Rijsbergen, K. (2004). *The Geometry of Information Retrieval*. Cambridge.
51. ^ Widdows, D. (2006). Geometry and meaning. *CSLI Publications*,

University of Chicago Press.

52. ^ Aerts, D., Czachor, M. (2004). Quantum aspects of semantic analysis and symbolic artificial intelligence. *Journal of Physics A 37*, L123-L132.
53. ^ https://www.rosoka.com/sites/default/files/ParserlessExtraction.pdf
54. ^ Atmanspacher, H., Filk, T., Romer, H. (2004). Quantum zeno features of bi-stable perception. *Biological Cybernetics 90*, 33–40.
55. ^ Conte, E., Todarello, O., Federici, A., Vitiello, F., Lopane, M., Khrennikov, A., Zbilut, J. P. (2007). Some remarks on an experiment suggesting quantum-like behavior of cognitive entities and formulation of an abstract quantum mechanical formalism to describe cognitive entity and its dynamics. *Chaos, Solitons & Fractals 31* (5), 1076–1088 doi: 10.1016/j.chaos.2005.09.061, arXiv:0710.5092 (submitted 26 October 2007).
56. ^ Conte, E., Khrennikov, A., Todarello, O., Federici, A., Zbilut, J. P. (2009). Mental states follow quantum mechanics during perception and cognition of ambiguous figures. *Open Systems and Information Dynamics 16*, 1–17.
57. ^ Conte, E., Khrennikov A., Todarello, O., De Robertis, R., Federici, A., Zbilut, J. P. (2011). On the possibility that we think in a quantum mechanical manner: An experimental verification of existing quantum interference effects in cognitive anomaly of Conjunction Fallacy. *Chaos and Complexity Letters 4*, 123–136.
58. ^ Conte, E., Santacroce, N., Laterza, V., Conte, S., Federici A., Todarello, O. (2012). The brain knows more than it admits: A quantum model and its experimental confirmation. *Electronic Journal of Theoretical Physics 9*, 72–110.
59. ^ [a] [b] Anton Amann: The Gestalt Problem in Quantum Theory: Generation of Molecular Shape by the Environment, Synthese, vol. 97, no. 1 (1993), pp. 125–156, jstor 20117832
60. ^ Haven E. and Khrennikov A. Quantum Social Science, Cambridge University Press, 2012.
61. ^ Asano, M., Ohya, M., Tanaka, Y., Basieva, I., Khrennikov, A., 2011. Quantum-like model of brain's functioning: Decision making from decoherence. Journal of Theoretical Biologyvol. 281, no. 1, pp. 56–64.

62. ^ Asano, M., Basieva, I., Khrennikov, A., Ohya, M., Yamato, I. 2013. Non-Kolmogorovian Approach to the Context-Dependent Systems Breaking the Classical Probability Law Foundations of Physics, vol. 43, no 7, pp. 895–911.
63. ^ Asano, M., Basieva, I., Khrennikov, A., Ohya, M., Tanaka, Y. Yamato, I. 2012. Quantum-like model for the adaptive dynamics of the genetic regulation of E. coli's metabolism of glucose/lactose. System Synthetic Biology vol. 6(1–2) pp. 1–7.
64. ^ B.J. Hiley: *Particles, fields, and observers*, Volume I The Origins of Life, Part 1 Origin and Evolution of Life, Section II The Physical and Chemical Basis of Life, pp. 87–106 (PDF)
65. ^ Basil J. Hiley, Paavo Pylkkänen: *Naturalizing the mind in a quantum framework*. In Paavo Pylkkänen and Tere Vadén (eds.): Dimensions of conscious experience, Advances in Consciousness Research, Volume 37, John Benjamins B.V., 2001, ISBN 90-272-5157-6, pages 119–144
66. ^ *Paavo Pylkkänen. "Can quantum analogies help us to understand the process of thought?" (PDF). Mind & Matter.* ***12*** *(1): 61–91.* p. 83–84.

Further reading

- Busemeyer, J. R. & Bruza, P. D. (2012). Quantum models of cognition and decision. Cambridge University Press.
- Conte, E. (2012) Advances in application of quantum mechanics in neuroscience and psychology: a Clifford algebraic approach, Nova Science Publishers.
- Ivancevic, V. and Ivancevic, T. (2010) *Quantum Neural Computation*. Springer.
- Tarlacı, S., 2010a. A Historical View of the Relation Between Quantum Mechanics and the Brain: A NeuroQuantologic Perspective. NeuroQuantology 8(2), 120–136). doi: 10.14704/nq.2010.8.2.278
- Tarlacı, S., 2010. Why We Need Quantum Physics for Cognitive Neuroscience. NeuroQuantology 8(1), 66–76. doi: 10.14704/nq.2010.8.1.271
- Tarlacı, S., 2011. Quantum Physics in Living Matter: From Quantum Biology to Quantum Neurobiology. NeuroQuantology 9(4), 692–701.
- Tarlacı, S., 2012. Physics, Mysticism, Postmodern Craze, and the Latest Fashions. NeuroQuantology 10(2), 140–43. doi: 10.14704/nq.2012.10.2.441
- Tarlacı, S., 2012. Ten Years of NeuroQuantology: A Long and Narrow Road. NeuroQuantology 10(1), 1–8. doi: 10.14704/nq.2012.10.1.524
- Tarlacı, S., 2012. The Measurement Problem in Quantum Mechanics: Well, Where's the Problem? NeuroQuantology 10(2), 216–229.
- Tarlacı, S., 2014. NeuroQuantology: Quantum Physics in the Brain. Reducing the Secret of the Rainbow to the Colours of a Prism. Nova Publisher, New York. ISBN 978-1-63117-301-1
- Tegmark, M., 2000. The importance of quantum decoherence in brain processes. Phys. Rev. E. 61, 4194.
- Thaheld, F.H., 2010. Quantum Nonlocality: Does Nature also Perform the Trick Via a Biological Route? NeuroQuantology 8(2), 164-167 doi: 10.14704/nq.2010.8.2.282
- Hameroff, S., Penrose, R., 2003. Conscious Events as Orchestrated Space-Time Selections. NeuroQuantology 1(1), 10–35. doi: 10.14704/nq.2003.1.1.3
- Hameroff, S., Penrose, R., 2014. Consciousness in the universe A review of the ‘Orch OR’ theory. Physics of Life Reviews 11, 39–78.
- Hameroff, S., 1998. Anesthesia, consciousness and hydrophobic pockets-a unitary quantum hypothesis of anesthetic action. Toxicol Lett. 23, 100–101.
- Hameroff, S., 2001. Consciousness, the brain, and space-time geometry. Annals of The New York Academy of Sciences 929, 74–1004.

- Hameroff, S., 2007. Orchestrated Reduction of Quantum Coherence in Brain Microtubules: A Model for Consciousness. NeuroQuantology 5(1), 1–8. doi: 10.14704/nq.2007.5.1.114
- Hameroff, S., 2006. The entwined mysteries of anesthesia and consciousness: is there a common underlying mechanism? Anesthesiology 105(2), 400–12.

TOC Previous

External links

- Busemeyer, J. R (2011). "Quantum Cognition and Decision Notes". Indiana University. "Life is complex, it has both real and imaginary parts"
- Aerts, Diederik (2010). "Home page". *Leo Apostel Centre (CLEA)*. Brussels Free University (VUB).
- "Quantum Decision Theory (QDT)". *School of Management*. University of Leicester. 2007.
- Blutner, Reinhard. "Quantum Cognition".
- "Quantum Interaction". 2011.
- Gabora, Liane (2014). "Studies of Creative and Evolutionary Processes (SCEP)". *Research Group*. UBC Okanagan.
- "School of Advanced International Studies for Applied Theoretical and Non Linear Methodologies of Physics (SAISTMP)". *Department of Biomedical Sciences and Oncology*. Human Physiology. University of Bari.
- "Website of the Quantum Cognition and Nonlinear Psychology research group at the University of Sussex, UK". *School of Psychology*. University of Sussex.
- "Neuro Quantology". *NeuroQuantology*. ISSN 1303-5150.

Categories: Quantum information theory | Cognitive modeling | Cognitive science | Decision theory

This page was last edited on 8 June 2018, at 01:19.

Back to main TOC

Contents

Noogenesis

Noogenesis (Ancient Greek: *νοῦς*=mind + *γένεσις* = origin, becoming) is the emergence and evolution of intelligence.[1]

Term origin

Noo, nous (UK: /'naUs /, US: /'nu:s /) – from the ancient Greek νόος, has synonyms in other languages 智慧 (Chinese), is a term that currently encompasses the semantics: mind, intelligence, intellect, reason; wisdom; insight, intuition, thought, - in a single phenomenon[2] [3] [4].

Noogenesis was first mentioned in the posthumously published in 1955 book *The Phenomenon of Man* by Pierre Teilhard de Chardin, an anthropologist and philosopher, in a few places:

The lack of any kind of definition of the term has led to a variety of interpretations reflected in the book,[9][10][11] including "the contemporary period of evolution on Earth, signified by transformation of biosphere onto the sphere of intelligence—noosphere",[12] "evolution run by human mind" [13] etc. The most widespread interpretation is thought to be "the emergence of mind, which follows geogenesis, biogenesis and anthropogenesis, forming a new sphere on Earth— noosphere".

TOC Previous Next

Recent developments

Modern understanding

In 2005 Alexey Eryomin in the monograph Noogenesis and Theory of Intellect[15] proposed a new concept of noogenesis in understanding the evolution of intellectual systems,[16] concepts of intellectual systems, information logistics, information speed, intellectual energy, intellectual potential, consolidated into a theory of the intellect[17] which combines the biophysical parameters of intellectual energy—the amount of information, its acceleration (frequency, speed) and the distance it's being sent—into a formula.[18] According to the new concept—proposed hypothesis continue prognostic progressive evolution of the species *Homo sapiens*,[19] the analogy between the human brain with the enormous amount of neural cells firing at the same time and a similarly functioning human society.[20]

A new understanding of the term "noogenesis" as an evolution of the intellect was proposed by A. Eryomin. A hypothesis based on recapitulation theory links the evolution of the human brain to the development of human civilization. The parallel between the amount of people living on Earth and the amount of neurons becomes more and more obvious leading us to viewing global intelligence as an analogy for human brain. All of the people living on this planet have undoubtedly inherited the amazing cultural treasures of the past, be it production, social and intellectual ones. We are genetically hardwired to be a sort of "live RAM" of the global intellectual system. Alexey Eryomin suggests that humanity is moving towards a unified self-contained informational and intellectual system. His research has shown the probability of Super Intellect realizing itself as Global Intelligence on Earth. We could get closer to understanding the most profound patterns and laws of the Universe if these kinds of research were given enough attention. Also, the resemblance between the individual human development and such of the whole human race has to be explored further if we are to face some of the threats of the future.[21]

Therefore, generalizing and summarizing:

Interdisciplinary nature

The term "noogenesis" can be used in a variety of fields i.e. medicine,[23][24] biophysics,[25] semiotics,[26] mathematics,[27] information technology,[28] psychology, theory of global evolution[29] etc. thus making it a truly cross-disciplinary one. In astrobiology noogenesis concerns the origin of intelligent life and more specifically technological civilizations capable of communicating with humans and or traveling to Earth.[30] The lack of evidence for the existence of such extraterrestrial life creates the Fermi paradox.

Aspects of emergence and evolution of mind

TOC Previous Next

To the parameters of the phenomenon "noo", "intellectus"

The emergence of the human mind is considered to be one of the five fundamental phenomenons of emergent evolution.[31] To understand the mind, it is necessary to determine how human thinking differs from other thinking beings. Such differences include the ability to generate calculations, to combine dissimilar concepts, to use mental symbols, and to think abstractly.[32] The knowledge of the phenomenon of intelligent systems—the emergence of reason (noogenesis) boils down to:

- Emergence and evolution of the " sapiens " (phylogenesis);
- A conception of a new idea (insight , creativity synthesis, intuition , decision-making , eureka);
- Development of an individual mind (ontogenesis);
- Appearance of the Global Intelligence concept.[15]

Several published works which do not employ the term "noogenesis", however, address some patterns in the emergence and functioning of the human intelligence: working memory capacity ≥ 7,[33] ability to predict, prognosis ,[34] hierarchical (6 layers neurons) system of information analysis ,[35] consciousness ,[36] memory,[37] generated and consumed information properties[38] etc. They also set the limits of several physiological aspects of human intelligence.[39] Conception of emergence of insight.[40]

TOC Previous Next

Aspects of evolution "sapiens"

Historical evolutionary development[41] and emergence of *H. sapiens* as species,[42] include emergence of such concepts as anthropogenesis, phylogenesis, morphogenesis , cephalization ,[43] systemogenesis,[44]

cognition systems autonomy.[45]

On the other hand, development of an individual's intellect deals with concepts of embryogenesis, ontogenesis,[46] morphogenesis, neurogenesis,[47] higher nervous function of I.P.Pavlov and his philosophy of mind.[48] Despite the fact that the morphofunctional maturity is usually reached by the age of 13, the definitive functioning of the brain structures is not complete until about 16–17 years of age.[49]

TOC Previous Next

The future of intelligence

Further information: Intelligence amplification

Bioinformatics, genetic engineering, noopharmacology, cognitive load, brain stimulation, the efficient use of altered states of consciousness, use of non-human cognition, information technology (IT), artificial intelligence (AI) are all believed to be effective methods of intelligence advancement.[21][50]

TOC Previous Next

Issues and further research prospects

The development of the human brain, perception, cognition, memory and neuroplasticity are unsolved problems in neuroscience. Several megaprojects are being carried out in: American BRAIN Initiative, European Human Brain Project, China Brain Project, Blue Brain Project, Allen Brain Atlas, Human Connectome Project, Google Brain, - in attempt to better our understanding of the brain's functionality along with the intention to develop human cognitive performance in the future with artificial intelligence, informational, communication and cognitive technology.[51]

See also

- Autopoiesis
- Abiogenesis
- Biological neural network
- Cognitive science
- Collective consciousness
- Collective intelligence
- Emergence
- Evolution
- Evolution of human intelligence
- Evolutionary neuroscience
- Global brain
- Human evolution
- Information ecology
- Information society
- Intelligence
- Knowledge commons
- Knowledge ecosystem
- Knowledge management
- Management cybernetics
- Mind
- Neuroinformatics
- Neuroscience and intelligence
- Psychophysics
- Sensory system
- Social organism
- Sociology of knowledge
- Superorganism
- Territoriality (nonverbal communication)
- World Brain

TOC Previous

References

1. ^ Noogenesis // Word Info about English Vocabulary
2. ^ *The Shorter Oxford English Dictionary on Historical Principles (3 ed.), Oxford University Press, 1973, p. 1417*
3. ^ See entry for *νόος* in Liddell & Scott, on the Perseus Project.
4. ^ See entry for *intellectus* in Lewis & Short, on the Perseus Project.
5. ^ Pierre Teilhard de Chardin The Phenomenon of Man. Harper Torchbooks, The Cloister Library, Harper & Row, Publishers, 1961, p. 181.
6. ^ Pierre Teilhard de Chardin The Phenomenon of Man. Harper Torchbooks, The Cloister Library, Harper & Row, Publishers, 1961, p. 270.
7. ^ Pierre Teilhard de Chardin The Phenomenon of Man. Harper Torchbooks, The Cloister Library, Harper & Row, Publishers, 1961, p. 273.
8. ^ Pierre Teilhard de Chardin The Phenomenon of Man. Harper Torchbooks, The Cloister Library, Harper & Row, Publishers, 1961, p. 290.
9. ^ Glycerio, M. L. & Paulsen, J. B. (1999). Is Noogenesis Progressing? Richmond, VA. [1]
10. ^ Steinhart E. Teilhard de Chardin and Transhumanism // Journal of Evolution and Technology — Vol. 20 Issue 1 -December 2008 — pgs 1-22 ISSN 1541-0099 [2]
11. ^ Bailey Sherwin, Christianity and evolution // The Eugenics Review. 1960 October; 52(3): 168—169. [3]
12. ^ Noogenesis // Environmental encyclopedic dictionary. — Chisinau: editorial of the Moldovan Soviet encyclopedia. — 1990. — 408 p. (ISBN 5-88550-006-1)
13. ^ Yatsenko N. E. Explanatory dictionary of social science terms. - Lan. — 1999. — 528 p. (ISBN 5-8114-0167-1)
14. ^ Eryomin A.L. The Laws of Evolution of the Mind // 7th International Teleconference on "Actual Problems of Modern Science". Tomsk, 2012. – P. 133-134.
15. ^ ***a b c d*** Eryomin A.L. **Noogenesis and Theory of Intellect**.

Krasnodar, 2005. — 356 p. (ISBN 5-7221-0671-2)
16. ^ Dombrovskaya I.S.To the problem of psychological analysis of the cultural genesis of humor // Cultural-historical psychology. 2010. №3. P. 57-59.
17. ^ Kononovich V.G. The basis of security - oriented information theory. Part 2. There are the informative fields in physical and informative world // Digital Tehnologies. – 2011 - № 9. Archived 2016-03-04 at the Wayback Machine.
18. ^ Mamedova M.D. The Concept of "Mind" in Chinese and Russian Linguistic Morld-images (on the material of phraseological units, proverbs and sayings). Dushanbe: Russian-Tajik (Slavonic) University, 2015. 245 pp. [*permanent dead link*]
19. ^ Ovchinnikov B. C. Convergence of psychology and psychiatry on the basis of the theory of biological evolution // Bulletin of the South Ural State University. Series: Psychology № 19 (278) / 2012. C.98-104.
20. ^ Orehov B.D. Forecasting of the development of mankind with regard to factor of knowledge. Zhukovsky: MIM LINK, 2015. – 210 p.
21. ^ *a* *b* Krivosheev S. **World Mind** // Itogy, 2005. - №26(472), P. 77-79.
22. ^ Eryomin A.L. Noogenesis and Theory of Intellect. Krasnodar, 2005. — p.20, p.331.
23. ^ Schneemann N. Light perception and noogenesis. Psychother Psychosom Med Psychol. 1983 Sep;33(5):183-8.
24. ^ Vieira AB. Noogenesis of catatonia. For an outline of phenomenologic anthropology. Evol Psychiatr (Paris). 1972 Oct-Dec;37(4):675-92.
25. ^ Eryomin A.L. Biophysical Fundamentals of the Evolution of the Humankind Mind // Biophysics. Vol. 48, No. 3. 2003. p.544. Translated from Biofizika - Russian Academy of Sciences, Vol. 48, No. 3. 2003. P. 573.
26. ^ Lozovskiy V. Towards the semiotics of noosphere [4] // International Journal «Information Theories & Applications» 2003. Vol.10, pp.29-36 ISSN 1313-0463
27. ^ Abraham Ralph H. Mathematics and evolution [5]: A

manifesto//World Futures: The Journal of Global Education 1987 Volume 23, Issue 4, pp. 237—261.

28. ^ Hofkirchner W. How to Design the Infosphere: the Fourth Revolution, the Management of the Life Cycle of Information, and Information Ethics as a Macroethics [6] //Knowledge, Technology & Policy, 23 (2010), 1-2; S. 177—192.
29. ^ Moiseyev N.N. Noogenesis—the fundamental problem of our time // World Futures. The Journal of New Paradigm Research, Volume 32, 1991 - Issue 4, P. 197-206
30. ^ Ćirković M.M. (2009). Fermi's paradox: The last challenge for copernicanism? Serbian Astronomical Journal 178:1-20 doi: 10.2298/SAJ0978001C
31. ^ Emergence. Encyclopædia Britannica. 2017.
32. ^ Hauser M. The Origin of the Mind // Scientific American. - 2009. September. 301. - P. 44-51. Archived 2010-03-25 at the Wayback Machine.
33. ^ Read D.W. Working memory: A Cognitive Limit to Non-Human Primate Recursive Thinking Prior to Hominid Evolution Archived 2012-01-31 at the Wayback Machine. // Evolutionary Psychology. 2008. — V.6.- P.676-714
34. ^ Kaku M. The Future of the Mind. 2015. - 502 p.
35. ^ Hawkins J., Blakeslee S. On Intelligence. NY: Times books, 2005. — 240 p.ISBN 0-8050-7456-2
36. ^ Ramachandran V.S. The Emerging Mind, 2003 (ISBN 1-86197-303-9).
37. ^ Kandel E. (2006). In Search of Memory: The Emergence of a New Science of Mind. W. W. Norton & Company. ISBN 978-0393329377.
38. ^ Lyman P., Varian H.R. How Much Information? 2003 / Release of the University of California. Oct.27, 2003. — 112 pp.
39. ^ Fox D. The limits of Intelligence. Scientific American. June No14, 2011.
40. ^ *Kandel, Eric R. (2012), The Age of Insight: The Quest to Understand the Unconscious in Art, Mind, and Brain, from Vienna 1900 to the Present, New York: Random House, ISBN 978-1-4000-6871-5*
41. ^ Darwin, Ch. On the Origin of Species by Means of Natural

Selection, or the Preservation of Favoured Races in the Struggle for Life. — 1st ed.. — London: John Murray, 1859.
42. ^ Linnaeus Carl *Systema naturae sive regna tria naturae systematice proposita per classes, ordines, genera, & species.* Lugduni Batavorum [Leyden]: apud Theodorum Haak. 1735. Djvu-файл (2 Mb)
43. ^ Dana J. D., Cephalization a Fundamental Principle in the Development of the System of Animal Life . American Journal of Science, 3d Ser., Vol. XII, New Haven, October, 1876, pp. 245—251.
44. ^ Anokhin P. (1963), Systemogenesis as a General Regulator of Brain Development, Progress in Brain Research, Vol. 9, The Developing Brain, Amsterdam, Elsevier (pp.54-86).
45. ^ Maturano, U. & Varela, F. Autopoiesis and cognition: the realization of the living. Springer, 1980. pp.141.
46. ^ Haeckel E. Generelle Morphologie der Organismen, 1866 [7]
47. ^ Zhao C, Deng W, Gage FH. Mechanisms and functional implications of adult neurogenesis. Cell. 2008;132:645-660 PMID 18295581
48. ^ Russell, Bertrand (1931) *The Scientific Outlook*, London: George Allen & Unwin.
49. ^ Farber D. A. Ontogenesis of brain structures// Scientific bases of psychology (ed. by A. A. Smirnova, A. R. Luria, V. D. Nebylitsyn). Moscow:Pedagogika, 1978. P. 255-277.
50. ^ Kurzweil R. How to Create a Mind. 2015. - 352 p Archived 2016-01-31 at the Wayback Machine.. (ISBN 978-5-699-81143-4)
51. ^ Seung S. Connectome. 2015. - 440 p. (ISBN 978-5-9963-1685-4)

Categories:

- Intelligence
- Emergence
- Mind
- Self
- Cognitive science
- Philosophical anthropology
- Evolutionary psychology

- Evolutionary biology

This page was last edited on 11 June 2018, at 08:22.

Back to main TOC

Contents

Spatial Relation

Jump to navigation Jump to search

A **spatial relation**,[1][2] specifies how some object is located in space in relation to some reference object. When the reference object is much bigger than the object to locate, the latter is often represented by a point. The reference object is often represented by a bounding box.

In Anatomy it might be the case that a spatial relation is not fully applicable. Thus, the degree of applicability is defined which specifies from 0 till 100% how strongly a spatial relation holds. Often researchers concentrate on defining the applicability function for various spatial relations.

In spatial databases and Geospatial topology the *spatial relations* are used for *spatial analysis* and constraint specifications.

In cognitive development for walk and for catch objects, or for understand objects-behaviour; in robotic Natural Features Navigation; and many other areas, *spatial relations* plays a central role.

Commonly used types of *spatial relations* are: *topological*, *directional* and *distance* relations.

TOP

TOC Next

Topological relations

Main article DE-9IM.

The DE-9IM model expresses important *space relations* which are invariant to rotation, translation and scaling transformations.

For any two spatial objects *a* and *b*, that can be points, lines and/or polygonal areas, there are 9 relations derived from *DE-9IM*:

TOC Previous Next

Directional relations

Directional relations can again be differentiated into external directional relations and internal directional relations. An internal directional relation specifies where an object is located inside the reference object while an external relations specifies where the object is located outside of the reference objects.

- Examples for internal directional relations: left; on the back; athwart, abaft
- Examples for external directional relations: on the right of; behind; in front of, abeam, astern

TOC | Previous | Next

Distance relations

Distance relations specify how far is the object away from the reference object.

- Examples are: at; nearby; in the vicinity; far away

TOC Previous Next

Relations by class

Reference objects represented by a bounding box or another kind of "spatial envelope" that encloses its borders, can be denoted with the maximum number of dimensions of this envelope: `0` for punctual objects, `1` for linear objects, `2` for planar objectss, `3` for volumetric objects. So, any object, in a 2D modeling, can by classifyed as *point*, *line* or *area* according to its delimitation. Then, a *type of spatial relation* can be expressed by the class of the objects that participate in the relation:

- point-point relations: ...
- point-line relations:
- point-area relations:
- line-line relations:
- line-area relations:
- area-area relations:

More *complex* modeling schemas can represent an object as a composition of *simple sub-objects*. Examples: represent in a astronomical map a star by a *point* and a binary star by *two points*; represent in geographical map a river with a *line*, for its source stream, and with an strip-*area*, for the rest of the river. These schemas can use the above classes, uniform composition classes (*multi-point*, *multi-line* and *multi-area*) and heterogeneous composition (*points*+*lines* as "object of dimension 1", *points*+*lines*+*areas* as "object of dimension 2").

Two internal components of a *complex object* can express (the above) binary relations between them, and ternary relations, using the whole object as a frame of reference. Some relations can be expressed by an abstract component, such the center of mass of the binary star, or a center line of the river.

Temporal references

For human thinking, spatial relations include qualities like size, distance, volume, order, and, also, time:

Stockdale and Possin[3] discusses the many ways in which people with difficulty establishing spatial and temporal relationships can face problems in ordinary situations.

See also

- Anatomical terms of location
- Dimensionally Extended nine-Intersection Model (DE-9IM)
- Water-level task
- Allen's interval algebra (temporal analog)
- Commonsense reasoning

TOC Previous

References

1. ^ J Freeman (1975), "The modelling of spatial relations", Computer Graphics and Image Processing, Elsevier. DOI: 10.1016/S0146-664X(75)80007-4
2. ^ D. M. Mark and M. J. Egenhofer (1994), "Modeling Spatial Relations Between Lines and Regions: Combining Formal Mathematical Models and Human Subjects Testing". PDF
3. ^ C. Stockdale and C. Possin (1998) Spatial Relations and Learning.

Categories:

- Cognitive science

This page was last edited on 14 September 2017, at 22:38.

Back to main TOC

Contents

Construction Grammar

Jump to navigation Jump to search
For the TV show also sometimes abbreviated "CXG", see Crazy Ex-Girlfriend (TV series).

In linguistics, **construction grammar** groups a number of models of grammar that all subscribe to the idea that knowledge of a language is based on a collection of "form and function pairings". The "function" side covers what is commonly understood as *meaning*, *content*, or *intent*; it usually extends over both conventional fields of semantics and pragmatics.

Language users learn these pairings as individual, whole facts about language. These language facts are indexed to specific interactive contexts and/or linguistic practices.[1] They may be associated in the mind of the language user with a highly particularized sociolect, dialect, pattern of jargon, genre,[2] or register.

The guiding insight of **construction grammar** (often abbreviated **CxG**) is that rules of syntactic combination are directly associated with interpretive and use conditions. All construction-based grammars allow units bigger than the word as semantic building blocks of syntax.[3] One example is the bipartite clausal pattern sometimes referred to as the Correlative Conditional construction, as found in the proverbial expression *The bigger they come, the harder they fall* [4][5][6]; another is the Copula Doubling construction exemplified by *The thing is, is you never really know* [7]. In contrast to traditional compositional approaches to syntax, in which all conceptual content comes from the lexicon, and rules of syntactic combination do no more than determine which word sequences function as units for syntactic purposes, constructional approaches assume a continuum of idiomaticity (or generality) of expressions, from tightly bound idioms to fully productive patterns.[8] This fundamental commitment unites all of the varieties of CxG, whether or not formal

descriptive methods are used and whether the research program targets language development, second-language learning, typology, diachrony, language productions and comprehension, language evolution, conversational practice or social identity. Owing to its focus on descriptive precision, patterns of usage, grammaticalization and the structure of linguistic categories, CxG is closely linked to the explanatory frameworks of cognitive-functional linguistics.

TOP

TOC Next

History

Historically, the notion of construction grammar developed out of the ideas of "global rules" and "transderivational rules"[*example needed*] in generative semantics, together with the generative semantic idea of a grammar as a constraint satisfaction system. George Lakoff's "Syntactic Amalgams" paper in 1974 (Chicago Linguistics Society, 1974) posed a challenge for the idea of transformational derivation.

Construction grammar was spurred on by the development of Cognitive Semantics, beginning in 1975 and extending through the 1980s. Lakoff's 1977 paper, Linguistic Gestalts (Chicago Linguistic Society, 1977) was an early version of CxG, arguing that the meaning of the whole was not a compositional function of the meaning of the parts put together locally. Instead, he suggested, constructions themselves must have meanings.

Construction grammar was developed in the 1980s by linguists such as Charles Fillmore, Paul Kay, and George Lakoff. Construction grammar was developed in order to handle cases that intrinsically went beyond the capacity of generative grammar.

The earliest study was "There-Constructions," which appeared as Case Study 3 in George Lakoff's *Women, Fire, and Dangerous Things*.[9] It argued that the meaning of the whole was not a function of the meanings of the parts, that odd grammatical properties of Deictic There-constructions followed from the pragmatic meaning of the construction, and that variations on the central construction could be seen as simple extensions using form-meaning pairs of the central construction.

Fillmore et al.'s (1988) paper on the English *let alone* construction was a second classic. These two papers propelled cognitive linguists into the study of CxG.

Grammatical construction

In construction grammar, like in general semiotics, the grammatical construction is a pairing of form and content. The formal aspect of a construction is typically described as a syntactic template, but the form covers more than just syntax, as it also involves phonological aspects, such as prosody and intonation. The content covers semantic as well as pragmatic meaning.

The semantic meaning of a grammatical construction is made up of conceptual structures postulated in cognitive semantics: image-schemas, frames, conceptual metaphors, conceptual metonymies, prototypes of various kinds, mental spaces, and bindings across these (called "blends"). Pragmatics just becomes the cognitive semantics of communication—the modern version of the old Ross-Lakoff performative hypothesis from the 1960s.

The form and content are symbolically linked in the sense advocated by Langacker.

Thus a construction is treated like a sign in which all structural aspects are integrated parts and not distributed over different modules as they are in the componential model. Consequentially, not only constructions that are lexically fixed, like many idioms, but also more abstract ones like argument structure schemata, are pairings of form and conventionalized meaning. For instance, the ditransitive schema [S V IO DO] is said to express semantic content X CAUSES Y TO RECEIVE Z, just like *kill* means X CAUSES Y TO DIE.

In construction grammar, a grammatical construction, regardless of its formal or semantic complexity and make up, is a pairing of form and meaning. Thus words and word classes may be regarded as instances of constructions. Indeed, construction grammarians argue that all pairings of form and meaning are constructions, including phrase structures, idioms, words and even morphemes.

Syntax-lexicon continuum

Unlike the componential model, construction grammar denies any strict distinction between the two and proposes a *syntax-lexicon continuum*. The argument goes that words and complex constructions are both pairs of form and meaning and differ only in internal symbolic complexity. Instead of being discrete modules and thus subject to very different processes they form the extremes of a continuum (from regular to idiosyncratic): syntax > subcategorization frame > idiom > morphology > syntactic category > word/ lexicon (these are the traditional terms; construction grammars use a different terminology).

TOC Previous Next

Grammar as an inventory of constructions

In construction grammar, the grammar of a language is made up of taxonomic networks of families of constructions, which are based on the same principles as those of the conceptual categories known from cognitive linguistics, such as inheritance, prototypicality, extensions, and multiple parenting.

Four different models are proposed in relation to how information is stored in the taxonomies:

1. **Full-entry model**
   In the full-entry model information is stored redundantly at all relevant levels in the taxonomy, which means that it operates, if at all, with minimal generalization.[*example needed*]
2. **Usage-based model**
   The usage-based model is based on inductive learning, meaning that linguistic knowledge is acquired in a bottom-up manner through use. It allows for redundancy and generalizations, because the language user generalizes over recurring experiences of use.[*example needed*]
3. **Default inheritance model**
   According to the default inheritance model, each network has a default central form-meaning pairing from which all instances inherit their features. It thus operates with a fairly high level of generalization, but does also allow for some redundancy in that it recognizes extensions of different types.[*example needed*]
4. **Complete inheritance model**
   In the complete inheritance model, information is stored only once at the most superordinate level of the network. Instances at all other levels inherit features from the superordinate item. The complete inheritance does not allow for redundancy in the networks.[*example needed*]

Shift towards usage-based model

All four models are advocated by different construction grammarians, but since the late 1990s there has been a shift towards a general preference for the usage-based model.[*citation needed*] The shift towards the usage-based approach in construction grammar has inspired the development of several corpus-based methodologies of constructional analysis (for example, collostructional analysis).

TOC | Previous | Next

Synonymy and monotony

As construction grammar is based on schemas and taxonomies, it does not operate with dynamic rules of derivation. Rather, it is monotonic.

Because construction grammar does not operate with surface derivations from underlying structures, it adheres to functionalist linguist Dwight Bolinger's *principle of no synonymy*, on which Adele Goldberg elaborates in her book.[10]

This means that construction grammarians argue, for instance, that active and passive versions of the same proposition are not derived from an underlying structure, but are instances of two different constructions. As constructions are pairings of form and meaning[11], active and passive versions of the same proposition are not synonymous, but display differences in content: in this case the pragmatic content.

TOC Previous Next

Some construction grammars

As mentioned above, Construction grammar is a "family" of theories rather than one unified theory. There are a number of formalized Construction grammar frameworks. Some of these are:

Berkeley Construction Grammar

Berkeley Construction Grammar (BCG: formerly also simply called Construction Grammar in upper case) focuses on the formal aspects of constructions and makes use of a unification-based framework for description of syntax, not unlike head-driven phrase structure grammar. Its proponents/developers include Charles Fillmore, Paul Kay, Laura Michaelis, and to a certain extent Ivan Sag. Immanent within BCG works like Fillmore and Kay 1995[12] and Michaelis and Ruppenhofer 2001[13] is the notion that phrasal representations—embedding relations—should not be used to represent combinatoric properties of lexemes or lexeme classes. For example, BCG abandons the traditional practice of using non-branching domination (NP over N' over N) to describe undetermined nominals that function as NPs, instead introducing a determination construction that requires ('asks for') a non-maximal nominal sister and a lexical 'maximality' feature for which plural and mass nouns are unmarked. BCG also offers a unification-based representation of 'argument structure' patterns as abstract verbal lexeme entries ('linking constructions'). These linking constructions include transitive, oblique goal and passive constructions. These constructions describe classes of verbs that combine with phrasal constructions like the VP construction but contain no phrasal information in themselves.

Sign Based Construction Grammar

In the mid-2000s, several of the developers of BCG, including Charles Fillmore, Paul Kay, Ivan Sag and Laura Michaelis, collaborated in an

effort to improve the formal rigor of BCG and clarify its representational conventions. The result was Sign Based Construction Grammar (SBCG). SBCG[14][15] is based on a multiple-inheritance hierarchy of typed feature structures. The most important type of feature structure in SBCG is the sign, with subtypes word, lexeme and phrase. The inclusion of phrase within the canon of signs marks a major departure from traditional syntactic thinking. In SBCG, phrasal signs are licensed by correspondence to the mother of some licit construct of the grammar. A construct is a local tree with signs at its nodes. Combinatorial constructions define classes of constructs. Lexical class constructions describe combinatoric and other properties common to a group of lexemes. Combinatorial constructions include both inflectional and derivational constructions. SBCG is both formal and generative; while cognitive-functional grammarians have often opposed their standards and practices to those of formal, generative grammarians, there is in fact no incompatibility between a formal, generative approach and a rich, broad-coverage, functionally based grammar. It simply happens that many formal, generative theories are descriptively inadequate grammars. SBCG is generative in a way that prevailing syntax-centered theories are not: its mechanisms are intended to represent all of the patterns of a given language, including idiomatic ones; there is no 'core' grammar in SBCG. SBCG a licensing-based theory, as opposed to one that freely generates syntactic combinations and uses general principles to bar illicit ones: a word, lexeme or phrase is well formed if and only if it is described by a lexeme or construction. Recent SBCG works have expanded on the lexicalist model of idiomatically combining expressions sketched out in Sag 2012.[16]

TOC | Previous | Next

Goldbergian/Lakovian construction grammar

The type of construction grammar associated with linguists like Goldberg and Lakoff looks mainly at the external relations of constructions and the structure of constructional networks. In terms of form and function, this type of construction grammar puts psychological plausibility as its highest desideratum. It emphasizes experimental results and parallels with general cognitive psychology. It also draws on certain principles of cognitive

linguistics. In the Goldbergian strand, constructions interact with each other in a network via four inheritance relations: polysemy link, subpart link, metaphorical extension, and finally instance link.[10]

TOC Previous Next

Cognitive grammar

Sometimes, Ronald Langacker's cognitive grammar framework is described as a type of construction grammar. Cognitive grammar deals mainly with the semantic content of constructions, and its central argument is that conceptual semantics is primary to the degree that form mirrors, or is motivated by, content. Langacker argues that even abstract grammatical units like part-of-speech classes are semantically motivated and involve certain conceptualizations.

TOC Previous Next

Radical construction grammar

William A. Croft's radical construction grammar is designed for typological purposes and takes into account cross-linguistic factors. It deals mainly with the internal structure of constructions. Radical construction grammar is totally non- reductionist, and Croft argues that constructions are not derived from their parts, but that the parts are derived from the constructions they appear in. Thus, in radical construction grammar, constructions are likened to Gestalts. Radical construction grammar rejects the idea that syntactic categories, roles, and relations are universal and argues that they are not only language-specific, but also construction specific. Thus, there are no universals that make reference to formal categories, since formal categories are language- and construction-specific. The only universals are to be found in the patterns concerning the mapping of meaning onto form. Radical construction grammar rejects the notion of syntactic relations altogether and replaces them with semantic relations. Like Goldbergian/Lakovian construction grammar and cognitive grammar, radical construction grammar is closely related to cognitive linguistics, and like cognitive grammar, radical construction grammar appears to be based on the idea that form is semantically motivated.

Embodied construction grammar

Embodied construction grammar (ECG), which is being developed by the Neural Theory of Language (NTL) group at ICSI, UC Berkeley, and the University of Hawai‘i, particularly including Benjamin Bergen and Nancy Chang, adopts the basic constructionist definition of a grammatical construction, but emphasizes the relation of constructional semantic content to embodiment and sensorimotor experiences. A central claim is that the content of all linguistic signs involve mental simulations and are ultimately dependent on basic image schemas of the kind advocated by Mark Johnson and George Lakoff and so ECG aligns itself with cognitive linguistics. Like construction grammar, embodied construction grammar makes use of a unification-based model of representation. A non-technical introduction to the NTL theory behind embodied construction grammar as well as the theory itself and a variety of applications can be found in Jerome Feldman's *From Molecule to Metaphor: A Neural Theory of Language* (MIT Press, 2006).

Fluid construction grammar

Fluid construction grammar (FCG) was designed by Luc Steels and his collaborators for doing experiments on the origins and evolution of language.[17][18] FCG is a fully operational and computationally implemented formalism for construction grammars and proposes a uniform mechanism for parsing and production. Moreover, it has been demonstrated through robotic experiments that FCG grammars can be grounded in embodiment and sensorimotor experiences.[19] FCG integrates many notions from contemporary computational linguistics such as feature structures and unification-based language processing. Constructions are considered bidirectional and hence usable both for parsing and production. Processing is flexible in the sense that it can even cope with partially ungrammatical or incomplete sentences. FCG is called 'fluid' because it acknowledges the premise that language users constantly change and update their grammars. The research on FCG is conducted at Sony CSL

Paris and the AI Lab at the Vrije Universiteit Brussel.

Others

In addition there are several construction grammarians who operate within the general framework of construction grammar without affiliating themselves with any specific construction grammar program. There is a growing interest in the diachronic aspect of grammatical constructions and thus in the importation of methods and ideas from grammaticalization studies. Another area of growing interest is the pragmatics of pragmatic constructions. This is probably one of the reasons why the usage-based model is gaining popularity among construction grammarians. Another area of increasing interest among construction grammarians is that of language acquisition which is mainly due to Michael Tomasello's work. Mats Andrén coined the term multimodal constructions to account for constructions that incorporate both (conventionalized) gesture and speech.

See also

- Anankastic conditional
- Snowclone

References

1. ^ *Fischer, Kerstin (December 2015). "Conversation, Construction Grammar, and cognition". Language and Cognition. **7** (4): 563–588. doi:10.1017/langcog.2015.23. ISSN 1866-9808.*
2. ^ Michaelis, Laura A. and Hanbing Feng. 2015. What is this, Sarcastic Syntax? Constructions and Frames 7: 148–180
3. ^ *Boas, Hans, Ivan Sag and Paul Kay (2012). "Introducing Sign Based Construction Grammar" (PDF).*
4. ^ *Sag, Ivan (2010). "English Filler-Gap Constructions". Language. **86**: 486–545.*
5. ^ *Fillmore, Charles (1986). "Varieties of Conditional Sentences". Eastern States Conference on Linguistics. **3**: 163–182.*
6. ^ *Michaelis, Laura A. (1994-01-01). "A Case of Constructional Polysemy in Latin". Studies in Language. **18** (1): 45–70. doi:10.1075/sl.18.1.04mic. ISSN 0378-4177.*
7. ^ *Brenier, Jason, Laura Michaelis (2005). "Optimization via syntactic amalgam: Syntax-prosody mismatch and copula doubling" (PDF).*
8. ^ Kay, Paul and Laura A. Michaelis. 2012. Constructional Meaning and Compositionality. In C. Maienborn, K. von Heusinger and P. Portner (eds.), Semantics: An International Handbook of Natural Language Meaning. Vol. 3. Berlin: de Gruyter. 2271-2296
9. ^ *Lakoff, George (1987). Women, Fire, and Dangerous Things: What Categories Reveal about the Mind. Chicago: University of Chicago Press.*
10. ^ ***a*** ***b*** *Goldberg, Adele (1995). Constructions: A construction grammar approach to argument structure. Chicago/London: University of Chicago Press.*
11. ^ *Hoffmann, Thomas; Trousdale, Graeme (2013-04-18). Construction Grammar. doi:10.1093/oxfordhb/9780195396683.013.0001.*
12. ^ Fillmore, Charles J. and Paul Kay. 1995. A Construction Grammar Coursebook. Unpublished ms, University of California, Berkeley.
13. ^ Michaelis, L. A., & Ruppenhofer, J. 2001. Beyond alternations: A constructional account of the applicative pattern in German. Stanford: CSLI Publications.

14. ^ Boas, H.C. and Sag, I.A. eds., 2012. Sign-based construction grammar (pp. xvi+-391). CSLI Publications/Center for the Study of Language and Information.
15. ^ Michaelis, L.A., 2009. Sign-based construction grammar. The Oxford handbook of linguistic analysis, pp.155-176.
16. ^ Sag, Ivan A. (2012) Sign-Based Construction Grammar: An informal synopsis, in H. C. Boas and I. A. Sag, (eds), Sign-Based Construction Grammar. Stanford: CSLI Publications). 69-202
17. ^ *Steels, Luc, ed. (2011). Design Patterns in Fluid Construction Grammar. Amsterdam: John Benjamins.*
18. ^ *Steels, Luc, ed. (2012). Computational Issues in Fluid Construction Grammar. Heidelberg: Springer.*
19. ^ *Steels, Luc; Hild, Manfred, eds. (2012). Language Grounding in Robots. New York: Springer.*

Further reading

- Bergen, Benjamin and Nancy Chang. Embodied Construction Grammar in Simulation-Based Language Understanding. In press. J.-O. Östman and M. Fried (eds.). *Construction Grammar(s): Cognitive and Cross-Language Dimensions*. Johns Benjamins.
- Croft, William A. (2001). *Radical Construction Grammar: Syntactic Theory in Typological Perspective*. Oxford: Oxford University Press.
- Croft, William A. and D. Alan Cruse (2004). *Cognitive Linguistics*. Cambridge: Cambridge University Press.
- Feldman, Jerome A. (2006). *From Molecule to Metaphor: A Neural Theory of Language* . Cambridge : MIT Press.
- Fillmore, Charles, Paul Kay and Catherine O'Connor (1988). Regularity and Idiomaticity in Grammatical Constructions: The Case of *let alone*. *Language* 64: 501–38.
- Goldberg, Adele. (1995) *Constructions: A Construction Grammar Approach to Argument Structure*. Chicago: University of Chicago Press.
- Goldberg, Adele (2006). *Constructions at Work: The Nature of Generalization in Language*. Oxford: Oxford University Press.
- Hilpert, Martin (2014). *Construction Grammar and its Application to English*. Edinburgh: Edinburgh University Press.
- Lakoff, George (1987). *Women, Fire, and Dangerous Things: What Categories Reveal about the Mind*. Chicago: CSLI.
- Langacker, Ronald (1987, 1991). *Foundations of Cognitive Grammar*. 2 vols. Stanford: Stanford University Press.
- Michaelis, Laura A. and Knud Lambrecht (1996). Toward a Construction-Based Model of Language Function: The Case of Nominal Extraposition. *Language* 72: 215–247.
- Michaelis, Laura A. and Josef Ruppenhofer (2001). *Beyond Alternations: A Construction-Based Account of the Applicative Construction in German*. Stanford: CSLI Publications.
- Michaelis, Laura A. (2004). Type Shifting in Construction Grammar: An Integrated Approach to Aspectual Coercion. *Cognitive Linguistics* 15: 1–67.
- De Beule Joachim and Steels Luc (2005). Hierarchy in Fluid Construction Grammar. Lecture Notes in Artificial Intelligence (LNCS/LNAI) 3698 (2005) pages 1–15). Berlin: Springer.
- Steels, Luc and De Beule, Joachim (2006). Unify and merge in fluid construction grammars. In: Vogt, P., Sugita, Y., Tuci, E. and Nehaniv, C., editors, *Symbol Grounding and Beyond: Proceedings of the Third International Workshop on the Emergence and Evolution of Linguistic Communication, EELC 2006, Rome, Italy, September 30–October 1, 2006*, Lecture Notes in

Computer Science (LNCS/LNAI) Vol. 4211, Berlin. Springer-Verlag. pp. 197–223.

External links

- Construction Grammar
- Fluid Construction Grammar
- AI Lab Brussels
- Sony CSL Paris
- NTL Project

Categories: Cognitive linguistics | Cognitive science | Grammar frameworks | Semiotics

This page was last edited on 25 May 2018, at 21:03.

Back to main TOC

Contents

Expectation confirmation Theory

Jump to navigation Jump to search

Expectation confirmation theory (alternatively **ECT** or **expectation disconfirmation theory**) is a cognitive theory which seeks to explain post-purchase or post-adoption satisfaction as a function of expectations, perceived performance, and disconfirmation of beliefs. The structure of the theory was developed in a series of two papers written by Richard L. Oliver in 1977[1] and 1980.[2] Although the theory originally appeared in the psychology and marketing literatures, it has since been adopted in several other scientific fields, notably including consumer research and information systems, among others.

Theoretical constructs

Expectation confirmation theory involves four primary constructs: expectations, perceived performance, disconfirmation of beliefs, and satisfaction.

Expectations

Expectations refer to the attributes or characteristics that a person anticipates or predicts will be associated with an entity such as a product, service, or technology artifact. Expectations are posited to directly influence both perceptions of performance and disconfirmation of beliefs, and are posited to indirectly influence post-purchase or post-adoption satisfaction by way of a mediational relationship through the disconfirmation construct. Pre-purchase or pre-adoption expectations form the basis of comparison against which the product, service, or technology artifact is ultimately judged.

Perceived performance

Perceived performance refers to a person's perceptions of the actual performance of a product, service, or technology artifact. According to expectation confirmation theory, perceptions of performance are directly influenced by pre-purchase or pre-adoption expectations, and in turn directly influence disconfirmation of beliefs and post-purchase or post-adoption satisfaction. Perceived performance is also posited to indirectly influence post-purchase or post-adoption satisfaction by way of a mediational relationship through the disconfirmation construct.

Disconfirmation of beliefs

Disconfirmation of beliefs refers to the judgments or evaluations that a

person makes with respect to a product, service, or technology artifact. These evaluations or judgments are made in comparison to the person's original expectations. When a product, service, or technology artifact outperforms the person's original expectations, the disconfirmation is positive, which is posited to increase post-purchase or post-adoption satisfaction. When a product, service, or technology artifact underperforms the person's original expectations, the disconfirmation is negative, which is posited to decrease post-purchase or post-adoption satisfaction (i.e., to increase dissatisfaction).

TOC Previous Next

Satisfaction

Post-purchase or post-adoption *satisfaction* refers to the extent to which a person is pleased or contented with a product, service, or technology artifact after having gained direct experience with the product, service, or artifact. Expectation confirmation theory posits that satisfaction is directly influenced by disconfirmation of beliefs and perceived performance, and is indirectly influenced by both expectations and perceived performance by means of a mediational relationship which passes through the disconfirmation construct.

TOC Previous

References

1. ^ Oliver R. L, 1977, "Effect of Expectation and Disconfirmation on Postexposure Product Evaluations - an Alternative Interpretation," Journal of Applied Psychology, 62(4), p. 480.
2. ^ Oliver R. L, 1980, "A Cognitive Model of the Antecedents and Consequences of Satisfaction Decisions," Journal of Marketing Research, 17(4), p. 460.

Categories:

- Cognitive science

Back to main TOC

Contents

Learning Sciences

Jump to navigation Jump to search

learning sciences (**LS**) is an interdisciplinary field that works to further scientific understanding of learning as well as to engage in the design and implementation of learning innovations, and the improvement of instructional methodologies. Research in the learning science traditionally focuses on cognitive-psychological, social-psychological, and cultural-psychological foundations of human learning, as well as on the design of learning environments. Major contributing fields include cognitive science, computer science, educational psychology, anthropology, and applied linguistics. Over the past decade, researchers have also expanded their focus to the design of curricula, informal learning environments, instructional methods, and policy innovations.

TOP

TOC Next

Domain definition

As an emerging discipline, the learning sciences are still in the process of defining itself. Accordingly, the identity of the field is multifaceted, and varies from institution to institution. However, the International Society of Learning Sciences (ISLS, [1]) summarizes the field as follows: "Researchers in the interdisciplinary field of learning sciences, born during the 1990s, study learning as it happens in real-world situations and how to better facilitate learning in designed environments – in school, online, in the workplace, at home, and in informal environments. Learning sciences research may be guided by constructivist, social-constructivist, socio-cognitive, and socio-cultural theories of learning." ISLS has a large worldwide membership, is affiliated with two international journals: *Journal of the Learning Sciences*, and *International Journal of Computer Supported Collaborative Learning*, and sponsors the biennial Computer Supported Collaborative Learning conference and International Conference of the Learning Sciences on alternate years."

Although controlled experimental studies and rigorous qualitative research have long been employed in learning science, LS researchers often use design-based research methods. Interventions are conceptualized and then implemented in natural settings in order to test the ecological validity of dominant theory and to develop new theories and frameworks for conceptualizing learning, instruction, design processes, and educational reform. LS research strives to generate principles of practice beyond the particular features of an educational innovation in order to solve real educational problems, giving LS its interventionist character.

History

Several significant events have contributed to the international development of learning science. Perhaps the earliest history can be traced back to the cognitive revolution.

In the United States, an important effort to create a graduate program in learning science took place in 1983 when Jan Hawkins and Roy Pea proposed a joint program between Bank Street College and the New School for Social Research. Called "Psychology, Education, and Technology" (PET), the program had a planning grant supported by the Sloan Foundation. In the end the program would have required new faculty, though, and the institutions involved never established such a program. Roger Schank's arrival at Northwestern University in 1988 helped start the Institute for Learning Sciences. In 1991, Northwestern initiated the first learning science doctoral program, designed by and launched by Roy Pea as its first director. The program began accepting students in 1992, and after Pea became dean the program directorship was taken over by Brian Reiser. Since that time, a number of other high quality graduate programs in learning science began to appear around the world, and the field is continuing to be recognized as an innovative and influential area for education research and design.

The Journal of the Learning Sciences was first published in 1991, with Janet Kolodner as founding editor. Yasmin Kafai and Cindy Hmelo-Silver took over as editors in 2009, and then Iris Tabak and Joshua Radinsky took over as editors in 2013. *The International Journal of Computer-Supported Collaborative Learning* was established as a separate journal in 2006, edited by Gerry Stahl and Freiderich Hesse. These journals, while relatively new in the field of education research, rapidly escalated and continue to place in upper ranks of the Educational Research section of the Social Sciences Citation Index impact factor rankings.

The Institute for the Learning Sciences hosted the first International

Conference for the Learning Sciences (ICLS) in August 1991 at Northwestern University (edited by Lawrence Birnbaum, and published by the AACE but no longer available). The first biennial meeting of the ICLS also took place at Northwestern University, in 1994. The International Society of the Learning Sciences was established in 2002.

TOC | Previous | Next

Distinguishing characteristics

By integrating multiple fields, learning science extends beyond other closely related fields in distinguishable ways. For example, learning science extends beyond psychology, in that it also accounts for, as well as contributes to computational, sociological and anthropological approaches to the study of learning. Similarly, learning science draws inspiration from cognitive science, and is regarded as a branch of cognitive science; however, it gives particular attention to improving education through the study, modification, and creation of new technologies and learning environments, and various interacting and emergent factors that potentially influence the learning of humans.

Many learning science researchers employ design-based research methodology. The growing acceptance of design-based research methodology as a means for study is often viewed as a significant factor distinguishing learning science from many of the fields that contribute to it. By including design-based research within its methodological toolkit, learning science qualifies as a "design science", with characteristics in common with other design sciences that employ design science such as engineering and computer science. Learning science is also considered by some as having some degree of overlap with instructional design, although historically the two communities have come about in different ways and at times emphasized different programs of research, as described in a special issue of the journal *Educational Technology* in 2004.

However, it should be emphasized that design-based research is by no means the only research methodology used in the field. Many other methodologies—including computational modeling, experimental and quasi-experimental research, and non-interventionist ethnographic-style qualitative research methodologies—have long been and continue to be employed in learning science.

Associations and journals

- Cognition and Instruction
- Instructional Science, *An International Journal of the Learning Sciences*
- International Society of the Learning Sciences
- The Journal of the Learning Sciences
- The International Journal of Computer-Supported Collaborative Learning
- Network of Academic Programs in the Learning Sciences

Major research centers

- Institute of Learning Sciences and Higher Education, ETH Zurich, Switzerland
- Carnegie Mellon University
- Center for Research on Learning and Technology Indiana University
- CoCo - Centre for Computer Supported-learning and Cognition, The University of Sydney
- LinCS - The Linnaeus Centre for Research on Learning, Interaction and Mediated Communication in Contemporary Society, The University of Gothenburg
- Center for Learning and Knowledge Technologies , CeLeKT, Växjö University
- Centre for Learning Sciences and Technologies, Open University of the Netherlands CELSTEC
- Learning Research and Development Center - University of Pittsburgh
- Learning Sciences Research Institute - University of Illinois at Chicago
- Learning Sciences Research Institute - University of Nottingham, UK
- LIFE (Learning in Informal and Formal Environments) Science of Learning Center
- Learning Sciences Lab, National Institute of Education, Nanyang Technological University, Singapore
- Pittsburgh Science of Learning Center
- Science of Learning Center on Visual Language and Visual Learning (VL2)
- Science of Learning Research Centre (A Special Research Initiative of the Australian Research Council)
- Spatial Intelligence and Learning Center (SILC)
- Munich Center of the Learning Sciences (MCLS),Ludwig-Maxmilians University, Munich, Germany

- Educational Science and Technology, University of Twente, Enschede, The Netherlands
- The Learning Technologies Research Group, RWTH Aachen University, Aachen, Germany

TOC Previous Next

Graduate programs (alphabetical order)

- Arizona State University (Mary Lou Fulton Teachers College)
  - Masters of Learning Sciences
  - Ph.D. in Learning, Literacies, and Technologies
- Carnegie Mellon University
  - Masters of Educational Technology and Applied Learning Science (METALS)
  - Ph.D. in Human Computer Interaction, Learning Sciences and Learning Technologies track
- Clemson University
  - Ph.D. in Learning Sciences
- ETH Zurich (Institute of Learning Sciences and Higher Education)
  - Ph.D. in Learning Sciences
- Indiana University School of Education, Bloomington Indiana
  - Ph.D. in Learning and Development Science—Specialization in Learning Sciences
  - M.S. Ed. in Learning and Development Sciences –Learning Sciences Track
  - Certificate in Learning Sciences, Media, and Technology (online)
- Northwestern University (School of Education and Social Policy)
  - Ph.D. in Learning Sciences
  - M.A. in Learning Sciences
- University of Illinois at Chicago (Learning Sciences Research Institute)
  - Ph.D. in Learning Sciences
- University of Calgary - Werklund School of Education
  - Ph.D. in Learning Sciences
  - M.A. in Learning Sciences
- University of California, Berkeley — Graduate School of Education
  - M.A./Ph.D in Culture, Development, and the Learning Sciences

- University of Sydney
  - Master of Learning Sciences and Technology (Professional)
  - Master of Learning Sciences and Technology (Research)

Undergraduate programs

- Northwestern University

TOC | Previous | Next

See also

- Artificial intelligence
- Cognitive psychology
- Cognitive science
- Computer-supported collaborative learning
- Educational psychology
- Educational technology
- Malleable intelligence

References

- Anderson, J. R., Reder, L. M., & Simon, H. A. (1996). Situated learning and education. *Educational Researcher*, 25(4), 5-11.
- Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2(2), 141-178
- Carr-Chellman, A. & Hoadley, C. (Eds.) Learning sciences and instructional systems: Beginning the dialogue [Special issue]. (2004). *Educational Technology*, *44*(3).
- Greeno, J. G. (2006). *Learning in activity*. In K. Sawyer (ed.) Handbook of the Learning Sciences (pp. 79–96), Cambridge, MA: Cambridge University Press.
- Greeno, J. G., Collins, A. M., & Resnick, L. (1996). Cognition and learning. In D. Berliner and R. Calfee (Eds.) *Handbook of Educational Psychology*, (pp. 15–46). New York: MacMillan.
- Lave, J. (1996). The practice of learning: The problem with "context." In S. Chaiklin & J. Lave (Eds.) *Understanding practice: Perspectives on activity and context* (pp. 3–32). Boston, MA: Cambridge University Press.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.
- Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, 27(2), 4-13.
- Stahl, G., Koschmann, T., Suthers, D. (2006). *Computer-supported collaborative learning: An historical perspective*. In K. Sawyer (ed.) Handbook of the Learning Sciences (pp. 79–96), Cambridge, MA: Cambridge University Press.

Categories:

- Cognitive science
- Educational psychology

This page was last edited on 18 May 2018, at 21:16.

Back to main TOC

Contents

Cognitive Inhibition

Jump to navigation Jump to search

Cognitive inhibition refers to the mind's ability to tune out stimuli that are irrelevant to the task/process at hand or to the mind's current state. Cognitive inhibition can be done either in whole or in part, intentionally or otherwise.[1] Cognitive inhibition in particular can be observed in many instances throughout specific areas of cognitive science.

TOP

TOC Next

History

The early models of what would become the study and concept of cognitive inhibition were developed by Sigmund Freud. Inhibition was believed to play two primary roles: the prevention of unwanted thoughts or behaviors, and the repression of experiences from infancy and childhood.[2] Freud believed cognitive inhibition was not just a lack of awareness to stimuli but an active process, requiring a constant energy expenditure.[2]

Other early theories of cognitive inhibition focused on its central developmental mechanisms and were founded by Luria and Vygotsky, two Russian psychologists. They proposed that children acquire control of behavior and thought through internalized speech, and that they consciously exhibit a cognitively inhibitory process in order to regulate their own behavior. Cognitive inhibition was thought to develop as mental control over behavior developed.

During the past 30 years inhibitory mechanisms such as cognitive inhibition have not been particularly prominent in developmental psychology, but currently they are undergoing a revival in the study of inefficient inhibition (explored in a later section) and resource limitations. [2]

Developmental psychology

Cognitive inhibition can be seen at work during studies in developmental psychology. An experiment done by Friedman and Leslie[1] explained children's performance in the false belief task as relying on a critical inhibitory process. What this demonstrated is that reaching the age of 3 or 4 triggers cognitive inhibition ability formation.[1] The idea is that children who are 3 or 4 can suppress information from their cognitive experience in order to evaluate a situation from another's point of view. This is very important developmentally as it may interact with the formation of empathy: cognitive inhibition cannot be so great as to completely block one's experiences while evaluating another point of view, but must be strong enough to enable an accurate representation of that point of view. Other elements of cognitive inhibition that are studied in developmental psychology include memory formation [3] or memory inhibition. It has been demonstrated that intentional inhibition of memory commitment is not fully developed until adulthood, and is very difficult for children to accomplish. This illustrates the fact that cognitive inhibition tasks, such as those in memory processing, are a gradually acquired skill rather than instinctual. Other cognitive functions that are developed gradually throughout childhood include exercising self-control over retained representational structures of information and quickly adapting cognitive processing to changing behavioral situations. Both of these functions were determined to be present throughout development, but not at full capacity until young adulthood.[4] Evidently, the ability to intentionally ignore irrelevant details and to focus attention and cognitive ability on more relevant details is not present in young children and is a highly developmentally-related process.[3]

TOC Previous Next

Role in survival

Cognitive inhibition may have played a role in the survival of human children, in what is called betrayal trauma theory.[5] "In situations involving treacherous acts by a caregiver, a 'cognitive information blockage' may occur that results in an isolation of knowledge of the event from awareness".[6] This motivated forgetting caused by cognitive inhibition would have been necessary in the past to maintain the crucial relationship between child and caregiver so that the child would survive; therefore, cognitive inhibition has endured through evolution. For example, a parent or caregiver may have been abusive physically or emotionally to a child, perhaps not intentionally, but the effect would be the same to the child. However, the world outside the protection of the caregiver would be even less forgiving and almost certainly fatal to the child in ancient history. So, they cognitively inhibited the memory of the abuse in order to maintain the relationship.

TOC Previous Next

Behavioral psychology

Behavioral psychology may play an important part in the development of cognitive inhibition. Cognitive inhibition is believed to strongly influence both sexual and aggressive urges within human society. When signals or stimuli are perceived by an individual, the mind processes the information and the body elicits a response. However, in the case of sexual arousal or perceived aggressive behavior, the individual needs to exercise caution in the cognitive processing of the incoming signals. This is where cognitive inhibition plays its part, preventing the individual from cognitively processing the stimuli and selecting an inappropriate response, thus potentially saving crucial social relationships.[7] Behavior towards others in a social circle is strongly influenced by empathy, which can be seen as a form of cognitive inhibition. Empathy causes an individual to understand the physical/emotional pain and suffering of others. When an interaction occurs, cognitive inhibition on the part of the individual causes him or her to respond appropriately and avoid upsetting someone already in physical or emotional pain. Again, this is important in maintaining social relationships.

Behavioral control is an important application of cognitive inhibition in behavioral psychology, as is emotional control. Depression is an example of cognitive inhibition failure in emotion control. Correctly functioning cognitive inhibition would result in reduced selective attention to negative stimuli and retention of negative thoughts. "There is emerging evidence that depression is characterized by deficits in the inhibition of mood-congruent material. These deficits could result in prolonged processing of negative, goal-irrelevant aspects of presented information thereby hindering recovery from negative mood and leading to the sustained negative affect that characterizes depressive episodes".[8] Anger is another important emotion affected by cognitive inhibition. "Trait anger is a robust predictor of the angry and aggressive response to hostile situational input, but it is important to better understand the mechanisms underlying this personality...individuals low in trait anger systematically recruit cognitive control resources within hostile contexts".[9] When

situations that may elicit anger leading to violence arise, cognitive inhibition is used extensively. Hostile stimuli magnitude are considered and ignored to avoid confrontation. Social context situations that may be interpreted as hostile are processed, and through cognitive inhibition, logic and reasoning are used to handle the situation. When a degree of cognitive inhibition ability is absent in an individual, it can result in "trait anger", or frequent angry and violent outbursts at relatively inoffensive stimuli.[9] Without cognitive inhibition and its resulting omission of irrelevant or unimportant information, emotional stability can be compromised.

Behavioral neuroscience

Behavioral neuroscience applies the principles of neurobiology, to the study of physiological, genetic, and developmental mechanisms of behavior. Cognitive inhibition is caused by several different interacting biological factors. The first is the existence of inhibitory neurotransmitters, or chemicals emitted by brain cells to both communicate and inhibit communication between each other. " GABA, an inhibitory transmitter substance that has been implicated in certain simple behavioral measures of inhibition and the control of aggressive behavior, was discovered in the cerebral cortex in substantial quantities".[7] Given the cerebral cortex's importance in many brain functions such as memory and thought, the presence of the inhibitory substance GABA supports the cognitive inhibition processes that go on in this area of the brain. Serotonin and dopamine, which can play inhibitory roles as well, are present in the brain in large quantities. All three of these neurotransmitters are capable of "blocking" the transmissions between neurons, which can ultimately result in cognitive inhibition. In addition, the presence of inhibitory connections in the central nervous system has been firmly demonstrated (Eccles, 1969). A process known as lateral inhibition, which involves the capacity of an excited neuron to reduce the activity of its neighbors, is integral in the biology of cognitive inhibition. It provides much of the neural background behind it and explains what exactly is going on at the cellular level.

Theory of inefficient inhibition

Many contemporary cognitive theorists postulate models featuring a central pool "of mental resources that must be allocated to the various operations involved in processing, retaining, and reporting information".[2] This means that working memory and the various areas of the brain responsible for it are theoretically limited to a finite set of "mental resources" or mental capacity with which to carry out operation. Cognitive inhibition, of course, is responsible for determining what is relevant to the working memory and shuts out what is irrelevant, "freeing up space" and mental capacity needed for more pressing matters. In the theory of inefficient inhibition, cognitive inhibition does not perform its function fully, and a shortage of mental resources leads to decreased performance or inefficiency in tasks that require more mental capacity. While inefficient inhibition can result naturally in individuals diagnosed with mild cognitive impairment, this effect is especially pronounced in methamphetamine-dependent individuals.[10] Clinically, these individuals can be highly distractible and exhibit difficulty focusing, which illustrates the fact that cognitive inhibition is being impaired and that inefficient inhibition is resulting. Because of the nature of the psychoactive drug, the brain is unable or reduced in its capacity to shut out irrelevant stimuli to the task at hand, and so tries to process and respond to any and all stimuli. This is most likely due to the effects of methamphetamine on inhibitory neurotransmitters like GABA, discussed in an earlier section.

TOC Previous Next

Failure and deficits

If an individual experiences impaired or damaged cognitive inhibition abilities, the psychological results can be extremely debilitating. Patients with obsessive compulsive disorder can experience the effects of reduced cognitive inhibition. "Failures of inhibition were identified in treatment of adults with OCD.[11] In Go/No-Go tasks, subjects have to make a simple motor response (such as pressing a button) as quickly as possible when target stimuli are presented, and withhold the motor response when non-target stimuli are presented. Bannon et al. (2002) found that OCD patients made significantly more commission errors than matched panic disorder control subjects in a computerized task necessitating the inhibition of responses on a proportion of trials— OCD patients tended to make inappropriate motor responses to non-target stimuli".[12] Evidently, the cognitive inhibition that OCD patients experience can have such effects as impairing response time to significant stimuli and decreasing the ability to shut out irrelevant stimuli. This may be why OCD responses to certain stimuli can be difficult to control. Suicidal behavior may also be related to cognitive inhibition impairment.[13] In one meta-analysis involving 164 studies, it was discovered that executive dysfunction and higher cognitive inhibition deficit is positively correlated and more frequently found among patients with suicidal behaviors.[13] In attention-deficit/hyperactivity disorder (ADHD), studies of cognitive control have not emphasized the ability to actively suppress pre-potent mental representations.[14] This indicates that people diagnosed with ADHD experience an impaired cognitive inhibition ability and find it difficult to suppress irrelevant stimuli. The result is decreased mental representation control and perhaps a degree of working memory deficit. Finally, there are age-related effects on an individual's ability to execute cognitive inhibition, which mostly include language impairment. "In language production, older adults' increased word-finding deficits have been explained under *inhibitory deficit theory* as a consequence of their reduced ability to inhibit irrelevant words (competitors) that impair retrieval of the target".[15] When speaking, many older adults experience difficulty "finding" the words they want to use,

which is evidence of cognitive inhibition skills not functioning properly. Because they are not omitting synonyms or replacements entirely from their working memory (which can be considered irrelevant stimuli), they exhibit similar types of mental representation degradation that patients with depression, ADHD, or OCD indicate.

TOC Previous

References

1. ^ a b c MacLeod, Colin (2007). "Concept of Inhibition in Cognition" (PDF). Retrieved March 3, 2013.
2. ^ a b c d Dempster, F.N. (1995). "Chapter 1: A Historical Perspective". Interference and Inhibition in Cognition. **11**: 1–88. doi:10.1023/A:1021992632168. Retrieved March 3, 2013.
3. ^ a b Harnishfeger, Katherine (1995). "The Development of Cognitive Inhibition". San Diego, CA: Academic Press, Inc. Retrieved March 3, 2013.
4. ^ Davidson, Matthew; Dima Amso; Loren Cruess Anderson; Adele Diamond (2006). "Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching". Neuropsychologia. Neuropsychologia. **44** (11): 2037–2078. doi:10.1016/j.neuropsychologia.2006.02.006. PMC 1513793 . PMID 16580701.
5. ^ Freyd, Jennifer (2008). "What is a Betrayal Trauma? What is Betrayal Trauma Theory?". Encyclopedia of Psychological Trauma. New York: John Wiley & Sons: 76. Retrieved March 3, 2013.
6. ^ Todd, Peter; Ralph Hertwig; Ulrich Hoffrage (2004). "Evolutionary Cognitive Psychology" (PDF). Handbook of Evolutionary Psychology. Retrieved March 3, 2013.
7. ^ a b Dempster, F; A. Corkill (1999). "Neo-interference research and the development of intelligence". The development of intelligence. Hove. **51**: 215–243. JSTOR 10.1086/650572.
8. ^ Joorman, J; K.L. Yoon; U. Zetsche (2007). "Cognitive inhibition in depression". Applied and Preventive Psychology. **12**: 128–139. doi:10.1016/j.appsy.2007.09.002. Retrieved March 3, 2013.
9. ^ a b Robinson, Michael; Benjamin M. Wilkowski; Brian P. Meier; Sara K. Moeller; Adam K. Fetterman (2011). "Counting to ten milliseconds: Low-anger, but not high-anger, individuals pause following negative evaluations" (PDF). Cognition and Emotion. Psychology Press: 1–21. doi:10.1080/02699931.2011.579088. Retrieved March 3, 2013.

10. ^ *Salo, Ruth; Thomas E. Nordahl; Kate Possin; Martin Leamon; David R. Gibson; Gantt P. Galloway; Neil M. Flynn; Avishai Henik; Adolf Pfefferbaum; Edith V. Sullivan (2002). "Preliminary evidence of reduced cognitive inhibition in methamphetamine-dependent individuals" (PDF). Psychiatry Research.* ***111****: 65–74. doi:10.1016/s0165-1781(02)00111-7. Retrieved March 3, 2013.*
11. ^ *Rosenberg, D.R.; Dick, E.L.; O'Hearn, K.M.; Sweeney, J.A. (1997). "Response-inhibition deficits in obsessive-compulsive disorder; an indicator of dysfunction in frontostriatal circuits" (PDF). Psychiatry Neuroscience.* ***22*** *(1): 29–38. Retrieved March 3, 2013.*
12. ^ *Chamberlain, S.R.; A.D. Blackwell; N.A. Fineberg; T.W. Robbins; B.J. Sahakin (2005). "The neuropsychology of obsessive compulsive disorder: the importance of failures in cognitive and behavioural inhibition as candidate endophenotypic markers" (PDF). Neuroscience and Biobehavioral Reviews. Elsevier.* ***29*** *(3): 399–419. doi:10.1016/j.neubiorev.2004.11.006. PMID 15820546. Retrieved March 3, 2013.*
13. ^ *a b* *Richard-Devantoy, S.; F. Jollant; Z. Kefi; JP Olie; C. Annweiler; O. Beauchet; D. Le Gall (2012). "Deficit of cognitive inhibition in depressed elderly: a neurocognitive marker of suicidal risk". Journal of Affective Disorders. Elsevier.* ***140*** *(2): 193–199. doi:10.1016/j.jad.2012.03.006. PMID 22464009. Retrieved March 3, 2013.*
14. ^ *Engelhart, Paul E.; Joel T. Nigg; Laurie A. Carr; Fernanda Ferreia (2008). "Cognitive Inhibition and Working Memory in Attention-Deficient/Hyperactivity Disorder". Journal of Abnormal Psychology.* ***117*** *(3): 591–605. doi:10.1037/a0012593. PMID 18729611. Retrieved March 3, 2013.*
15. ^ *Zacks, R.T.; L. Hasher (1994). "Directed ignoring: Inhibitory regulation of working memory" (PDF). Inhibitory processes in attention, memory, and language. San Diego, CA: Academic Press: 241–264. Retrieved March 3, 2013.*

Categories:

- Cognitive science

This page was last edited on 8 March 2018, at 09:04.

Back to main TOC

Contents

Spatial–temporal Reasoning

Jump to navigation Jump to search
This article is about spatial-temporal reasoning in information technology. For spatial-temporal reasoning in psychology, see Spatial visualization ability.

Spatial–temporal reasoning is an area of artificial intelligence which draws from the fields of computer science, cognitive science, and cognitive psychology. The theoretic goal—on the cognitive side—involves representing and reasoning spatial-temporal knowledge in mind. The applied goal—on the computing side—involves developing high-level control systems of robots for navigating and understanding time and space.

TOP

TOC Next

Influence from cognitive psychology

A convergent result in cognitive psychology is that the connection relation is the first spatial relation that human babies acquire, followed by understanding orientation relations and distance relations. Internal relations among the three kinds of spatial relations can be computationally and systematically explained within the theory of cognitive prism as follows: (1) the connection relation is primitive; (2) an orientation relation is a distance comparison relation: you being in front of me can be interpreted as you are nearer to my front side than my other sides; (3) a distance relation is connection relations using a third object: you being one meter away from me can be interpreted as an object with the maximum extension of one meter can be connected with you and me simultaneously.

Fragmentary representations of temporal calculi

Without addressing internal relations among spatial relations, AI researchers contributed many fragmentary representations. Examples of temporal calculi include Allen's interval algebra, and Vilain's & Kautz's point algebra. The most prominent spatial calculi are mereotopological calculi, Frank's cardinal direction calculus, Freksa's double cross calculus, Egenhofer and Franzosa's 4- and 9-intersection calculi, Ligozat's flip-flop calculus, various region connection calculi (RCC), and the Oriented Point Relation Algebra. Recently, spatio-temporal calculi have been designed that combine spatial and temporal information. For example, the spatiotemporal constraint calculus (STCC) by Gerevini and Nebel combines Allen's interval algebra with RCC-8. Moreover, the qualitative trajectory calculus (QTC) allows for reasoning about moving objects.

TOC | Previous | Next

Quantitative abstraction

An emphasis in the literature has been on qualitative spatial-temporal reasoning which is based on qualitative abstractions of temporal and spatial aspects of the common-sense background knowledge on which our human perspective of physical reality is based. Methodologically, qualitative constraint calculi restrict the vocabulary of rich mathematical theories dealing with temporal or spatial entities such that specific aspects of these theories can be treated within decidable fragments with simple qualitative (non- metric) languages. Contrary to mathematical or physical theories about space and time, qualitative constraint calculi allow for rather inexpensive reasoning about entities located in space and time. For this reason, the limited expressiveness of qualitative representation formalism calculi is a benefit if such reasoning tasks need to be integrated in applications. For example, some of these calculi may be implemented for handling spatial GIS queries efficiently and some may be used for navigating, and communicating with, a mobile robot.

TOC Previous Next

Relation algebra

Most of these calculi can be formalized as abstract relation algebras, such that reasoning can be carried out at a symbolic level. For computing solutions of a constraint network, the path-consistency algorithm is an important tool.

TOC Previous Next

Software

- GQR, constraint network solver for calculi like RCC-5, RCC-8, Allen's interval algebra, point algebra, cardinal direction calculus, etc.

See also

- Cerebral cortex
- Diagrammatic reasoning
- Temporal logic
- Visual thinking
- Spatial ability

TOC Previous Next

Notes

References

- *Renz, J.; Nebel, B. (2007). Aiello, M.; Pratt-Hartmann, I.; van Benthem, J., eds. [Qualitative Spatial Reasoning using Constraint Calculi](PDF). Handbook of Spatial Logics. Springer. ISBN 9781402055867.*
- *Dong, T. "A COMMENT ON RCC: FROM RCC TO RCC++". Journal of Philosophical Logic.* ***34*** *(2): 319–352. JSTOR 41217909.*
- *Vilain, M.; Kautz, H.; van Beek, P. (1987). Constraint propagation algorithms for temporal reasoning: A Revised Report (PDF). Readings in qualitative reasoning about physical systems. Morgan Kaufmann Publishers. ISBN 1-55860-095-7.*
- *Dong, T. (2012). "Recognizing Variable Environment -- The Theory of Cognitive Prism". Studies in Computational Intelligence.* ***388****. Springer-Verlag, Berlin Heidelberg. ISBN 9783642240577.*

Categories:

- Cognitive science
- Knowledge representation
- Educational psychology
- Logical calculi
- Reasoning

This page was last edited on 14 September 2017, at 22:38.

Back to main TOC

Contents

Eye movement in Reading

Jump to navigation Jump to search

Eye movement in reading involves the visual processing of written text. This was described by the French ophthalmologist Louis Émile Javal in the late 19th century. He reported that eyes do not move continuously along a line of text, but make short, rapid movements (saccades) intermingled with short stops (fixations). Javal's observations were characterised by a reliance on naked-eye observation of eye movement in the absence of technology. From the late 19th to the mid-20th century, investigators used early tracking technologies to assist their observation, in a research climate that emphasised the measurement of human behaviour and skill for educational ends. Most basic knowledge about eye movement was obtained during this period. Since the mid-20th century, there have been three major changes: the development of non-invasive eye-movement tracking equipment; the introduction of computer technology to enhance the power of this equipment to pick up, record and process the huge volume of data that eye movement generates; and the emergence of cognitive psychology as a theoretical and methodological framework within which reading processes are examined. Sereno & Rayner (2003) believed that the best current approach to discover immediate signs of word recognition is through the recordings of eye movements and event-related potential.

TOP

TOC Next

History

Until the second half of the 19th century, researchers had at their disposal three methods of investigating eye movement. The first, unaided observation, yielded only small amounts of data that would be considered unreliable by today's scientific standards. This lack of reliability arises from the fact that eye movement occurs frequently, rapidly, and over small angles, to the extent that it is impossible for an experimenter to perceive and record the data fully and accurately without technological assistance. The other method was self-observation, now considered to be of doubtful status in a scientific context. Despite this, some knowledge appears to have been produced from introspection and naked-eye observation. For example, Ibn al Haytham, a medical man in 11th-century Egypt, is reported to have written of reading in terms of a series of quick movements and to have realised that readers use peripheral as well as central vision.[1]

Leonardo da Vinci, (1452–1519) may have been the first in Europe to recognize certain special optical qualities of the eye. He derived his insights partly through introspection but mainly through a process that could be described as optical modelling. Based on dissection of the human eye he made experiments with water-filled crystal balls. He wrote "The function of the human eye, ... was described by a large number of authors in a certain way. But I found it to be completely different."[2]

His main experimental finding was that there is only a distinct and clear vision at the "line-of-sight", the optical line that ends at the fovea. Although he did not use these words literally he actually is the father of the modern distinction between foveal vision (a more precise term for central vision) and peripheral vision. However, Leonardo did not know that the retina is the sensible layer, he still believed that the lens is the organ of vision.

There appear to be no records of eye movement research until the early 19th century. At first, the chief concern was to describe the eye as a

physiological and mechanical moving object, the most serious attempt being Hermann von Helmholtz's major work *Handbook of physiological optics* (1866). The physiological approach was gradually superseded by interest in the psychological aspects of visual input, in eye movement as a functional component of visual tasks. As early as the 1840s, there was speculation on the relationship between central and peripheral vision.[3]

The subsequent decades saw more elaborate attempts to interpret eye movement, including a claim that meaningful text requires fewer fixations to read than random strings of letters.[4][5] In 1879, the French ophthalmologist Louis Émile Javal used a mirror on one side of a page to observe eye movement in silent reading, and found that it involves a succession of discontinuous individual movements for which he coined the term saccades. In 1898, Erdmann & Dodge used a hand-mirror to estimate average fixation duration and saccade length with surprising accuracy.

TOC Next

Early tracking technology

Eye tracking device is a tool created to help measure eye and head movements. The first devices for tracking eye movement took two main forms: those that relied on a mechanical connection between participant and recording instrument, and those in which light or some other form of electromagnetic energy was directed at the participant's eyes and its reflection measured and recorded. In 1883, Lamare was the first to use a mechanical connection, by placing a blunt needle on the participant's upper eyelid. The needle picked up the sound produced by each saccade and transmitted it as a faint clicking to the experimenter's ear through an amplifying membrane and a rubber tube. The rationale behind this device was that saccades are easier to perceive and register aurally than visually.[6] In 1889, Edmund B. Delabarre invented a system of recording eye movement directly onto a rotating drum by means of a stylus with a direct mechanical connection to the cornea.[7] Other devices involving physical contact with the surface of the eyes were developed and used from the end of the 19th century until the late 1920s;

these included such items as rubber balloons and eye caps.

Mechanical systems suffered three serious disadvantages: questionable accuracy due to slippage of the physical connection, the considerable discomfort caused to participants by the direct mechanical connection (and consequently great difficulty in persuading people to participate), and issues of ecological validity, since participants' experience of reading in trials was significantly different from the normal reading experience. Despite these drawbacks, mechanical devices were used in eye movement research well into the 20th century.

Attempts were soon made to overcome these problems. One solution was to use electromagnetic energy rather than a mechanical connection. In the "Dodge technique", a beam of light was directed at the cornea, focused by a system of lenses and then recorded on a moveable photographic plate. Erdmann & Dodge[8] used this technique to claim that there is little or no perception during saccades, a finding that was later confirmed by Utall & Smith using more sophisticated equipment. The photographic plate in the Dodge technique was soon replaced with a film camera, but was still plagued by problems of accuracy, due to the difficulty of keeping all parts of the equipment perfectly aligned throughout a trial and accurately compensating for the distortion caused by the diffractive qualities of photographic lenses. In addition, it was usually necessary to restrain a participant's head by using an uncomfortable bite-bar or head-clamp.

In 1922, Schott pioneered a further advance called electro-oculography (EOG), a method of recording the electrical potential between the cornea and the retina.[9] Electrodes may be covered with special contact paste before being placed on the skin. So, it is now unnecessary to make incisions in patient's skin. Common misconception about EOG is that measured potential is the electromyogram of extraocular muscles. In fact, it is only the projection of eye dipole to the skin, because higher frequencies, corresponding to EMG, are filtered out. EOG delivered considerable improvements in accuracy and reliability, which explain its continued use by experimentalists for many decades.[10][11][12]

Modern Eye Tracking

There are 4 major cognitive systems involved in eye movement in reading: Language processing, attention, vision, and oculomotor control.[13] Eye trackers bounce near infra-red light off the interior of the eyeball, and monitor the reflection on the eye to determine gaze location. With this technique, the exact position of eye fixation on a screen is determinable.[14] Wang (2011) mentioned that a video-based eye-tracker which uses video cameras to record the eye position of human subjects, thereby recording pupil dilation and eye movements, can be used to examine how fixations, saccades, and pupil dilation responses are related to the information on the screen and behavioral choices during an experiment. According to Wang (2011:185), "understanding the relationship between these observables can help us to understand how human behavior in the economy can be affected by what information people acquire, where their attention is focused, what emotional state they are in, and even what brain activity they are engaged in.[*citation needed*] This is because fixations and saccades (matched with information shown on screen) indicate how people acquire information (and what they see), time lengths of fixations indicate attention, and pupil dilation responses indicate emotion, arousal, stress, pain, or cognitive load."

TOC Previous Next

Saccades

Skilled readers move their eyes during reading on the average of every quarter of a second. During the time that the eye is fixated, new information is brought into the processing system. Although the average fixation duration is 200–250 ms (thousandths of a second), the range is from 100 ms to over 500 ms.[15] The distance the eye moves in each saccade (or short rapid movement) is between 1 and 20 characters with the average being 7–9 characters. The saccade lasts for 20–40 ms and during this time vision is suppressed so that no new information is acquired.[16] There is considerable variability in fixations (the point at which a saccade jumps to) and saccades between readers and even for the same person reading a single passage of text. Skilled readers make regressions back to material already read about 15 percent of the time. The main difference between faster and slower readers is that the latter group consistently shows longer average fixation durations, shorter saccades, and more regressions.[17] These basic facts about eye movement have been known for almost a hundred years, but only recently have researchers begun to look at eye movement behavior as a reflection of cognitive processing during reading.[18]

The lower line of text simulates the acuity of vision with the relative acuity percentages. The difficulty of recognizing text increases with the distance from the fixation point.[19]

TOC | Previous | Next

Dyslexia

People with dyslexia generally suffer from a decreased reading speed, which can be caused by many different variables. There are many remedies to try and combat these deficits, depending on what biological theory of dyslexia they are based on. One such idea is based on magnocellular deficit, where magnocellular pathways are uncoordinated, causing the skipping or re-reading of lines.[20]

TOC Previous Next

Computer models of eye movement in reading

Competition-Interaction Theory and SERIF emphasise low level oculomotor processes in reading such as how the word length of the currently fixated word and its neighbour words affect saccade amplitude and latency (or fixation duration). Reader, EMMA, E-Z Reader and SWIFT emphasise higher level cognitive processes such as lexical processing, word frequency, word parsing or word predictability.[*citation needed*]

TOC Previous Next

See also

- Biological theories of dyslexia
- Eye movement
- Eye movement in music reading
- Gaze-contingency paradigm
- Reading
- Fixation (visual)
- Eye tracking
- Eye tracking device
- Foveal

TOC Previous Next

Notes

1. ^ Heller (1988:39).
2. ^ Leonardo da Vinci (1955), das Lebensbild eines Genies, Emil Vollmer Verlag, Wiesbaden Berlin. Dokumentation der Davinci Ausstellung in Mailand 1938, p. 430; cited in 'Hans-Werner Hunziker, (2006) Im Auge des Lesers: foveale und periphere Wahrnehmung – vom Buchstabieren zur Lesefreude' [In the eye of the reader: foveal and peripheral perception – from letter recognition to the joy of reading] Transmedia Stäubli Verlag Zürich 2006 ISBN 978-3-7266-0068-6.
3. ^ Hueck (1840),[*citation needed*] Weber (1846).
4. ^ Cattell (1885, 1886).
5. ^ Rayner, Pollatsek, & Alexander (2005).
6. ^ Lamare (1893).
7. ^ Delabarre (1898).
8. ^ Erdmann B & Dodge R (1898).
9. ^ Schott E (1922).
10. ^ Finocchio, Preston, & Fuchs (1990).
11. ^ Liu, Zhou, Hu (2011).
12. ^ Tecce, Pok, Consiglio, O'Neil (2005).
13. ^ *"Eye Movements During Reading". Pitt.edu. Retrieved 2014-04-14.*
14. ^ wang (2011).
15. ^ Sereno & Rayner (2003).
16. ^ Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg (2001).
17. ^ Rayner, Slattery, Belanger (2010).
18. ^ Rayner K (1975).
19. ^ Hans-Werner Hunziker, (2006) Im Auge des Lesers: foveale und periphere Wahrnehmung – vom Buchstabieren zur Lesefreude [In the eye of the reader: foveal and peripheral perception – from letter recognition to the joy of reading] Transmedia Stäubli Verlag Zürich 2006, ISBN 978-3-7266-0068-6.
20. ^ Stein J., The magnocellular theory of developmental dyslexia Dyslexia. 2001 Jan–Mar;7(1):12–36.

References

- Abadi, R. V. (2006). Vision and eye movements. Clinical and Experimental Optometry, 55–56.
- Delabarre E.B. (1898) A method of recording eye-movements, *Psychological Review* 8, 572–74.
- Engbert, R. & Kliegl, R. (2011) Parallel graded attention models of reading. The Oxford handbook of eye movements. Liversedge, S., Gilchrist, I., & Everling, S. (Eds.) Oxford University Press.
- Erdmann B & Dodge R (1898) *Psychologische Untersuchung über das Lesen auf experimenteller Grundlage*, Niemeyer: Halle.
- Finocchio, Dom; Preston, Karen L; Fuchs, Albert F. (1990). "Obtaining a quantitative measure of eye movements in human infants: A method of calibrating the electrooculogram". *Vision Research* 30(8): 1119–28. doi: 10.1016/0042-6989(90)90169-L.
- Heller D (1988) "On the history of eye movement recording" in *Eye movement research: physiological and psychological aspects*, Toronto: CJ Hogrefe, 37–51.
- Helmholtz H (1866) *Handbuch der physiologischen Optik*, Voss: Hamburg.
- Hunziker, H. (2006). Im Auge des Lesers: foveale und periphere Wahrnehmung – vom Buchstabieren zur Lesefreude [In the eye of the reader: foveal and peripheral perception – from letter recognition to the joy of reading] Transmedia Stäubli Verlag Zürich 2006, ISBN 978-3-7266-0068-6.
- Javal, E. (1878) "Essai sur la physiologie de la lecture", in *Annales d'ocullistique* 80, 61–73.
- Just, M.A., & Carpenter, P.A. (1980). A theory of reading: from eye fixations to comprehension. Psychological review, 87(4), 329.
- Lamare, M. (1893) Des mouvements des yeux pendants la lecture, *Comptes rendus de la société française d'ophthalmologie*, 35–64.
- Liu, Y.; Zhou, Z.; Hu, D. (2011). "Gaze independent brain-computer speller with covert visual search tasks". *Clinical Neurophysiology* 122(6): 1127–36. doi: 10.1016/j.clinph.2010.10.049. Retrieved 1 November 2011.

- McDonald, S. A., Carpenter, R. H. S., & Shillcock, R. C. (2005). An anatomically constrained, stochastic model of eye movement control in reading. Psychological review, 112(4), 814.
- Nuthmann, A. (2014, September). Eye movements and visual cognition lecture 2 (University of Edinburgh, UK).
- Rayner, K.; Foorman, B.; Perfetti, C.; Pesetsky, D. & Seidenberg, M. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest 2(2): 31–74.*
- Rayner, K.; Slattery, Timothy J; Belanger, Nathalie N. (2010). Eye movements, the perceptual span, and reading speed. *Psychonomic Bulletin & Review* 17(6): 834–39. doi: 10.3758/PBR.17.6.834. Retrieved 1 November 2011.
- Rayner K. (1975). Eye movements, perceptual span, and reading disability, Annals of Dyslexia, 33(1), 163–73. doi: 10.1007/BF02648003
- Rayner; K.; Pollatsek, J.; Alexander, B.(2005). *Eye movements during reading. The science of reading: A handbook.* [1-4051-1488-6]: Blackwell Publishing. pp. 79–97. ISBN 1-4051-1488-6 (Hardcover); 978-1-4051-1488-2.
- Reichle, E. (2011). *Serial-attention models of reading. The Oxford handbook of eye movements*. Liversedge, S., Gilchrist, I., & Everling, S. (Eds.) Oxford University Press.
- Reichle, E.D., Rayner, K., & Pollatsek, A. (2003). The EZ Reader model of eye-movement control in reading: comparisons to other models. Behavioral and Brain Sciences, 26(04), 445–76.
- Salvucci, D.D. (2001). An integrated model of eye movements and visual encoding. *Cognitive Systems Research*, 1(4), 201-220.
- Schott E (1922) Über die Registrierung des Nystagmus und anderer Augenbewegungen vermittels des Saitengalvanometers, *Deutsches Archiv für klinisches Medizin* 140, 79–90.
- Sereno, S.; Rayner, K. (2003). Measuring word recognition in reading: eye movements and event-related potentials. *Trends in Cognitive Sciences*, 7(11): 489–93.
- Tecce, J.; Pok, L.J.; Consiglio, M.R.; O'Neil, J.L. (2005). Attention impairment in electrooculographic control of computer functions. *International Journal of Psychophysiology*, 55(2): 159–63. doi: 10.1016/j.ijpsycho.2004.07.002. Retrieved 1 November 2011.

- Vitu, F., McConkie, G.W., Kerr, P., & O'Regan, J.K. (2001). Fixation location effects on fixation durations during reading: An inverted optimal viewing position effect. *Vision research*, 41(25), 3513–33.
- Wang, J. (2011). "Pupil dilation and eye-tracking." A handbook of process tracing methods for decision research: a critical review and user's guide: Society for Judgment and Decision Making Series. pp. 185–204. ISBN 1-84872-864-6.
- Yang, S.-N., & McConkie, G.W. (2001). Eye movements during reading: a theory of saccade initiation times. Vision Research, 41, 3567–85.

External links

Categories:

- Reading (process)
- Cognitive science
- Eye
- Motor control

This page was last edited on 5 June 2018, at 19:56.

Back to main TOC

Contents

Social Neuroscience

Jump to navigation Jump to search
For the journal, see Social Neuroscience.

Social neuroscience is an interdisciplinary field devoted to understanding how biological systems implement social processes and behavior, and to using biological concepts and methods to inform and refine theories of social processes and behavior. Humans are fundamentally a social species, rather than individualists. As such, *Homo sapiens* create emergent organizations beyond the individual—structures that range from dyads, families, and groups to cities, civilizations, and cultures. These emergent structures evolved hand in hand with neural and hormonal mechanisms to support them because the consequent social behaviors helped these organisms survive, reproduce, and care for offspring sufficiently long that they too survived to reproduce. The term "social neuroscience" can be traced to a publication entitled "Social Neuroscience Bulletin" that was published quarterly between 1988 and 1994. The term was subsequently popularized in an article by John Cacioppo and Gary Berntson, published in the American Psychologist in 1992.[1] Cacioppo and Berntson are considered as the legitimate fathers of social neuroscience. Still a young field, social neuroscience is closely related to affective neuroscience and cognitive neuroscience, focusing on how the brain mediates social interactions.[2]

TOP

TOC Next

Overview

Traditional neuroscience has for many years considered the nervous system as an isolated entity and largely ignored influences of the social environments in which humans and many animal species live. In fact, we now recognize the considerable impact of social structures on the operations of the brain and body. These social factors operate on the individual through a continuous interplay of neural, neuroendocrine, metabolic and immune factors on brain and body, in which the brain is the central regulatory organ and also a malleable target of these factors.[3] Social neuroscience investigates the biological mechanisms that underlie social processes and behavior, widely considered one of the major problem areas for the neurosciences in the 21st century, and applies concepts and methods of biology to develop theories of social processes and behavior in the social and behavioral sciences. Social neuroscience capitalizes on biological concepts and methods to inform and refine theories of social behavior, and it uses social and behavioral constructs and data to advance theories of neural organization and function.[4][5]

Throughout most of the 20th century, social and biological explanations were widely viewed as incompatible. But advances in recent years have led to the development of a new approach synthesized from the social and biological sciences. The new field of social neuroscience emphasizes the complementary relationship between the different levels of organization, spanning the social and biological domains (e.g., molecular, cellular, system, person, relational, collective, societal) and the use of multi-level analyses to foster understanding of the mechanisms underlying the human mind and behavior.

Methods

A number of methods are used in social neuroscience to investigate the confluence of neural and social processes. These methods draw from behavioral techniques developed in social psychology, cognitive psychology, and neuropsychology, and are associated with a variety of neurobiological techniques including functional magnetic resonance imaging (fMRI), magnetoencephalography (MEG), positron emission tomography (PET), facial electromyography (EMG), transcranial magnetic stimulation (TMS), electroencephalography (EEG), event-related potentials (ERPs), electrocardiograms, electromyograms, endocrinology, immunology, galvanic skin response (GSR), single-cell recording, and studies of focal brain lesion patients.[6][7][8][9][10] Animal models are also important to investigate the putative role of specific brain structures, circuits, or processes (e.g., the reward system and drug addiction). In addition, quantitative meta-analyses are important to move beyond idiosyncrasies of individual studies, and neurodevelopmental investigations can contribute to our understanding of brain-behavior associations.[11][12] The two most popular forms of methods used in social neuroscience are fMRI and EEG. fMRI are very cost efficient and high in spatial resolution. However, they are low in temporal resolution and therefore, are best to discover pathways in the brain that are used during social experiments. fMRI have low temporal resolution (timing) because they read oxygenated blood levels that pool to the parts of the brain that are activated and need more oxygen. Thus, the blood takes time to travel to the part of the brain being activated and in reverse provides a lower ability to test for exact timing of activation during social experiments. EEG is best used when a researcher is trying to brain map a certain area that correlates to a social construct that is being studied. EEGs provide high temporal resolution but low spatial resolution. In which, the timing of the activation is very accurate but it is hard to pinpoint exact areas on the brain, researchers are to narrow down locations and areas but they also create a lot of "noise". Most recently, researchers have been using TMS which is the best way to discover the exact location in the process of brain mapping. This machine can turn on and off parts of the

brain which then allows researchers to test what that part of the brain is used for during social events. However, this machine is so expensive that it is rarely used.

Note: Most of these methods can only provide correlations between brain mapping and social events (apart from TMS), a con of Social Neuroscience is that the research must be interpreted through correlations which can cause a decreased content validity. For example, during an experiment when a participant is doing a task to test for a social theory and a part of the brain is activated, it is impossible to form causality because anything else in the room or the thoughts of the person could have triggered that response. It is very hard to isolate these variables during these experiments. That is why self-reports are very important. This will also help decrease the chances of VooDoo correlations (correlations that are too high and over 0.8 which look like a correlation exists between two factors but actually is just an error in design and statistical measures). Another way to avoid this con, is to use tests with hormones which can infer causality. For example, when people are given oxytocin and placebos and we can test their differences in social behavior between other people. Using SCRs will also help isolate unconscious thoughts and conscious thoughts because it is the body's natural parasympathetic response to the outside world. All of these tests and devices will help social neuroscientists discover the connections in the brain that are used to carry out our everyday social activities.

Primarily psychological methods include performance-based measures that record response time and/or accuracy,[13] such as the Implicit Association Test;[14] observational measures such as preferential looking in infant studies; and, self-report measures, such as questionnaire and interviews.[15]

Neurobiological methods can be grouped together into ones that measure more external bodily responses, electrophysiological methods, hemodynamic measures, and lesion methods. Bodily response methods include GSR (also known as skin conductance response (SCR)), facial EMG, and the eyeblink startle response. Electrophysiological methods include single-cell recordings, EEG, and ERPs. Hemodynamic measures, which, instead of directly measuring neural activity, measure changes in

blood flow, include PET and fMRI. Lesion methods traditionally study brains that have been damaged via natural causes, such as strokes, traumatic injuries, tumors, neurosurgery, infection, or neurodegenerative disorders. In its ability to create a type of 'virtual lesion' that is temporary, TMS may also be included in this category. More specifically, TMS methods involve stimulating one area of the brain to isolate it from the rest of the brain, imitating a brain lesion. This is particularly helpful in brain mapping, a key approach in social neuroscience designed to determine which areas of the brain are activated during certain activities.[16]

Society for Social Neuroscience

A dinner to discuss the challenges and opportunities in the interdisciplinary field of social neuroscience at the Society for Neuroscience meeting (Chicago, November 2009) resulted in a series of meetings led by John Cacioppo and Jean Decety with social neuroscientists, psychologists, neuroscientists, psychiatrists and neurologists in Argentina, Australia, Chile, China, Colombia, Hong Kong, Israel, Japan, the Netherlands, New Zealand, Singapore, South Korea, Taiwan, the United Kingdom, and the United States. Social neuroscience was defined broadly as the interdisciplinary study of the neural, hormonal, cellular, and genetic mechanisms underlying the emergent structures that define social species. Thus, among the participants in these meetings were scientists who used a wide variety of methods in studies of animals as well as humans, and patients as well as normal participants. The consensus also emerged that a Society for Social Neuroscience should be established to give scientists from diverse disciplines and perspectives the opportunity to meet, communicate with, and benefit from the work of each other. The international, interdisciplinary Society for social neuroscience (http://S4SN.org) was launched at the conclusion of these consultations in Auckland, New Zealand on 20 January 2010, and the inaugural meeting for the Society was held on November 12, 2010, the day prior to the 2010 Society for Neuroscience meeting (San Diego, CA).

See also

- Biocultural evolution
- Cognitive neuropsychology
- Emotion
- Motor cognition
- Social cognition
- *Social Cognitive and Affective Neuroscience*
- *Social Neuroscience*
- Social psychology
- Sociobiology

References

1. ^ *Cacioppo J. T.; Berntson G. G. (1992). "Social psychological contributions to the decade of the brain: Doctrine of multilevel analysis". American Psychologist.* ***47****: 1019–1028. doi:10.1037/0003-066x.47.8.1019. PMID 1510329.*
2. ^ *Cacioppo J. T.; Berntson G. G.; Decety J. (2010). "Social neuroscience and its relation to social psychology". Social Cognition.* ***28****: 675–684. doi:10.1521/soco.2010.28.6.675. PMC 3883133 .*
3. ^ Cacioppo, J. T., Berntson, G. G., & Decety, J. (2011). A history of social neuroscience. In A. W. Kruglanski and W. Stroebe (Eds.), Handbook of the History of Social Psychology. New York: Psychology Press.
4. ^ *Cacioppo J.T.; et al. (2007). "Social neuroscience: progress and implications for mental health". Perspectives on Psychological Science.* ***2****: 99–123. doi:10.1111/j.1745-6916.2007.00032.x.*
5. ^ *Cacioppo J. T.; Decety J. (2011). "Social neuroscience: challenges and opportunities in the study of complex behavior". Annals of the New York Academy of Sciences.* ***1224****: 162–173. doi:10.1111/j.1749-6632.2010.05858.x. PMC 3098127 . PMID 21251011.*
6. ^ *Adolphs R (2003). "Investigating the cognitive neuroscience of social behavior". Neuropsychologia.* ***41****: 119–126. doi:10.1016/s0028-3932(02)00142-2.*
7. ^ Cacioppo, J.T., & Berntson, G.G. (2009), Handbook of Neuroscience for the Behavioral Science. New York: John Wiley and Sons.
8. ^ Harmon-Jones, E., & Beer, J.S. (2009). Methods in Social Neuroscience. New York: The Guilford Press
9. ^ Ward, J. (2012). The Student's Guide to Social Neuroscience. New York: Psychology Press
10. ^ Subbaraju V, Sundaram S, Narasimhan S. Identification of lateralized compensatory neural activities within the social brain due to autism spectrum disorder in adolescent males. *European Journal of Neuroscience*. 2017.
11. ^ de Haan, M., & Gunnar, M.R. (2009). Handbook of Developmental Social Neuroscience. The Guilford Press.

12. ^ *Decety J.; Cacioppo T.T. (2010). "Frontiers in human neuroscience, the golden triangle, and beyond". Perspectives on Psychological Science.* ***5*** *(6): 767–771. doi:10.1177/1745691610388780. PMC 3904345* .
13. ^ Ward, J. (2012). The Student's Guide to Social Neuroscience. New York: Psychology Press
14. ^ *Greenwald A. G.; McGhee D. E.; Schwartz J. L. K. (1998). "Measuring individual differences in implicit cognition: The Implicit Association Test". Journal of Personality and Social Psychology.* ***74****: 1464–1480. doi:10.1037/0022-3514.74.6.1464.*
15. ^ Ward, J. (2012). The Student's Guide to Social Neuroscience. New York: Psychology Press
16. ^ Ward, J. (2012). The Student's Guide to Social Neuroscience. New York: Psychology Press

TOC | Previous | Next

Further reading

- Brune, M., Ribbert, H., & Schiefenhovel, W. (2003). The social brain: evolution and pathology. Hoboken, NJ: Wiley & Sons Ltd.
- *Cacioppo J.T. (2002). "Social neuroscience: Understanding the pieces fosters understanding the whole and vice versa". American Psychologist.* ***57****: 819–831. doi: 10.1037/0003-066x.57.11.819. PMID 12564179.*
- *Cacioppo J. T.; Berntson G. G. (1992). "Social psychological contributions to the decade of the brain: Doctrine of multilevel analysis". American Psychologist.* ***47****: 1019–1028. doi: 10.1037/0003-066x.47.8.1019. PMID 1510329.*
- *Cacioppo J.T.; Berntson G.G.; Sheridan J.F.; McClintock M.K. (2000). "Multilevel integrative analyses of human behavior: social neuroscience and the complementing nature of social and biological approaches". Psychological Bulletin.* ***126****: 829–843. doi: 10.1037/0033-2909.126.6.829. PMID 11107878.*
- *Cacioppo, John T.; Gary G. Berntson (2004). Social Neuroscience: Key Readings,. Psychology Press. ISBN 978-1-84169-099-5. Archived from the original on 2012-02-08..*
- *Cacioppo, John T.; Penny S. Visser, Cynthia L. Pickett (eds.) (2005). Social Neuroscience: People Thinking about Thinking People. MIT Press. ISBN 0-262-03335-6.*
- Cozolino, L. (2006). The Neuroscience of Human Relationships: Attachment And the Developing Social Brain. W. W. Norton & Company.
- de Haan, M., & Gunnar, M.R. (2009). Handbook of Developmental Social Neuroscience. The Guilford Press.
- Decety, J., & Cacioppo, J.T. (2011). Handbook of Social Neuroscience. New York: Oxford University Press.
- Decety, J., & Ickes, W. (2009). The Social Neuroscience of Empathy. Cambridge: MIT press.
- Emery, N.J. (2007). Cognitive Neuroscience of Social Behavior. Taylor & Francis.
- *Harmon-Jones, E.; P. Winkielman (2007). Social Neuroscience:*

Integrating Biological and Psychological Explanations of Social Behavior. Guilford Press. ISBN 978-1-59385-404-1..

- van Lange, P.A.M. (2006). Bridging social psychology: benefits of transdisciplinary Approaches. Mahwah, NJ: Lawrence Erlbaum Associates.
- *Ward, J. (2012). The Student's Guide to Social Neuroscience. New York. Psychology Press. ISBN 978-184872-005-3. Archived from the original on 2014-07-19.*
- Wolpert, D. & Frith, C. (2004). The Neuroscience of Social Interactions: Decoding, Influencing, and Imitating the Actions of Others. Oxford: Oxford University Press.

TOC Previous

External links

- Society for Social Neuroscience.
- New Society for Social Neuroscience to help guide emerging field from the University of Chicago News Office.
- University of Chicago Center for Cognitive and Social Neuroscience.
- "What is social neuroscience?" Introduction from the first issue (March 2006) of the journal Social Neuroscience defining social neuroscience, listing the tools of social neuroscience, and addressing the impact of social neuroscience.

Categories:

- Behavioral neuroscience
- Cognitive neuroscience
- Neuropsychology
- Cognitive science
- Branches of psychology
- Emergence

This page was last edited on 23 May 2018, at 05:04.

Back to main TOC

Contents

Grandmother Cell

The **grandmother cell** is a hypothetical neuron that represents a complex but specific concept or object.[1] It activates when a person "sees, hears, or otherwise sensibly discriminates"[2] a specific entity, such as his or her grandmother. The term was in use at least as early as 1966 amongst staff and students in the Department of Experimental Psychology, University of Cambridge, England. A similar concept, that of the **gnostic neuron**, was proposed two years later by Jerzy Konorski.[3]

Support

TOC Next

Face selective cells

Visual neurons in the inferior temporal cortex of the monkey fire selectively to hands and faces.[4][5][6][7] These cells are selective in that they do not fire for other visual objects important for monkeys such as fruit and genitalia. Research finds that some of these cells can be trained to show high specificity for arbitrary visual objects, and these would seem to fit the requirements of gnostic/grandmother cells.[8][9] In addition, evidence exists for cells in the human hippocampus that have highly selective responses to gnostic categories[10][11] including highly selective responses to individual human faces.[12]

However most of the reported face-selective cells are not grandmother/gnostic cells since they do not represent a specific percept, that is, they are not cells narrowly selective in their activations for one face and only one face irrespective of transformations of size, orientation, and color. Even the most selective face cells usually also discharge, if more weakly, to a variety of individual faces. Furthermore, face-selective cells often vary in their responsiveness to different aspects of faces. This suggests that cell responsiveness arises from the need of a monkey to differentiate among different individual faces rather than among other categories of stimuli such as bananas with their discrimination properties linked to the fact that different individual faces are much more similar to each other in their overall organization and fine detail than other kinds of stimuli.[1] Moreover, it has been suggested that these cells might in fact be responding as specialized feature detector neurons that only function in the holistic context of a face construct.[13][14]

One idea has been that such cells form ensembles for the coarse or distributed coding of faces rather than detectors for specific faces. Thus, a specific grandmother may be represented by a specialized ensemble of grandmother or near grandmother cells.[1]

Individual specific recognition cells

In 2005, a UCLA and Caltech study found evidence of different cells that fire in response to particular people, such as Bill Clinton or Jennifer Aniston. A neuron for Halle Berry, for example, might respond "to the concept, the abstract entity, of Halle Berry", and would fire not only for images of Halle Berry, but also to the actual name "Halle Berry".[15] However, there is no suggestion in that study that only the cell being monitored responded to that concept, nor was it suggested that no other actress would cause that cell to respond (although several other presented images of actresses did not cause it to respond).[15] The researchers believe that they have found evidence for sparseness, rather than for grandmother cells.[16]

Further evidence for the theory that a small neural network provides facial recognition was found from analysis of cell recording studies of macaque monkeys. By formatting faces as points in a high-dimensional linear space, the scientists discovered that each face cell’s firing rate is proportional to the projection of an incoming face stimulus onto a single axis in this space, allowing a face cell ensemble of about 200 cells to encode the location of any face in the space.[17]

Sparseness vs distributed representations

The grandmother cell hypothesis, is an extreme version of the idea of sparseness,[18][19] and is not without critics. The opposite of the grandmother cell theory is the distributed representation theory, that states that a specific stimulus is coded by its unique pattern of activity over a large group of neurons widely distributed in the brain.

The arguments against the sparseness include:

1. According to some theories, one would need thousands of cells for each face, as any given face must be recognised from many different angles – profile, 3/4 view, full frontal, from above, *etc*.
2. Rather than becoming more and more specific as visual processing proceeds from retina through the different visual centres of the brain, the image is partially dissected into basic features such as vertical lines, colour, speed, *etc*., distributed in various modules separated by relatively large distances. How all these disparate features are re-integrated to form a seamless whole is known as the binding problem.

TOC Previous Next

Pontifical cells

William James in 1890 proposed a related idea of a pontifical cell.[20] The pontifical cell is defined as a putative, and implausible cell which had all our experiences. It is in this different from a concept specific cell in that it is the site of experience of sense data. James's 1890 pontifical cell was instead a cell "to which the rest of the brain provided a representation" of a grandmother. The experience of grandmother occurred in this cell.

See also

- Alternative explanations of the "grandmother" cell

References

1. ^ a b c *Gross, CG (2002). " "Genealogy of the "Grandmother Cell"* (PDF)*. Neuroscientist.* ***8*** *(5): 512–518. doi:10.1177/107385802237175. PMID 12374433. Archived from the original* (PDF) *on 2008-08-29.*
2. ^ *Clark, Austen (2000). A Theory of Sentience. Oxford University Press. p. 43. ISBN 0-19-823851-7.*
3. ^ Konorski J. 1967. *Integrative activity of the brain; an interdisciplinary approach.*(1967)
4. ^ Gross CG. 1998a. *Brain, vision, memory: tales in the history of neuroscience.*
5. ^ *Perrett, DI; Rolls, ET; Caan, W (1982). "Visual neurons responsive to faces in the monkey temporal cortex". Exp Brain Res.* ***47****: 329–42. doi:10.1007/bf00239352.*
6. ^ Rolls ET. 1984. *Neurons in the cortex of the temporal lobe and in the amygdala of the monkey with responses selective for faces.* Hum Neurobiol 3:209–22.
7. ^ *Yamane, S; Kaji, S; Kawano, K (1988). "What facial features activate face neurons in the inferotemporal cortex of the monkey?". Exp Brain Res.* ***73****: 209–14. doi:10.1007/bf00279674.*
8. ^ *Logothetis, NK; Sheinberg, DL (1996). "Visual object recognition". Annu Rev Neurosci.* ***19****: 577–621. doi:10.1146/annurev.ne.19.030196.003045.*
9. ^ Tanaka K. 1996. *Inferotemporal cortex and object vision.* Annu Rev Neurosci 19:109–39.
10. ^ *Gross, CG (2000). "Coding for visual categories in the human brain". Nat Neurosci.* ***3****: 855–6. doi:10.1038/78745.*
11. ^ *Kreiman, G; Koch, C; Fried, I (2000). "Category specific visual responses of single neurons in the human medial temporal lobe". Nat Neurosci.* ***3****: 946–53. doi:10.1038/78868.*
12. ^ Kreiman G, Fried I, Koch C. 2001. *Single neuron responses in humans during binocular rivalry and flash suppression. Abstr Soc Neurosci* 27
13. ^ *Jagadeesh, B (2009). "Recognizing grandmother". Nat Neurosci.* ***12*** *(9): 1083–5. doi:10.1038/nn0909-1083. PMID 19710647.*
14. ^ *Freiwald, WA; Tsao, DY; Livingstone, MS (2009). "A face feature*

space in the macaque temporal lobe". *Nat Neurosci.* ***12*** *(9): 1187–96. doi:10.1038/nn.2363. PMC 2819705 . PMID 19668199.*
15. ^ *a* *b* *Quiroga, R.; et al. (2005). "Invariant visual representation by single neurons in the human brain". Nature.* ***435*** *(7045): 1102–1107. doi:10.1038/nature03687.*
16. ^ *Quiroga, R.; et al. (2008). "Sparse but not 'Grandmother-cell' coding in the medial temporal lobe". Trends in Cognitive Sciences.* ***12*** *(3): 87–91. doi:10.1016/j.tics.2007.12.003.*
17. ^ *Chang, Tsao (2017). "The Code for Facial Identity in the Primate Brain". Cell.* ***169****: 1013–1028. doi:10.1016/j.cell.2017.05.011 – via Elsevier Inc.*
18. ^ *Rugg, Michael (1997). Cognitive Neuroscience. MIT Press. pp. 49–58. ISBN 0-262-68094-7.*
19. ^ *Connor, Charles (23 June 2005). "Friends and grandmothers". Nature.* ***435*** *(7045): 1036–1037. doi:10.1038/4351036a. PMID 15973389.*
20. ^ James W. (1890). The principles of psychology. New York: Dover

Categories:

- Neural coding
- Cognitive science

This page was last edited on 24 January 2018, at 10:09.

Back to main TOC

Contents

Cognitive Semantics

Jump to navigation Jump to search

Cognitive semantics is part of the cognitive linguistics movement. Semantics is the study of linguistic meaning. Cognitive semantics holds that language is part of a more general human cognitive ability, and can therefore only describe the world as people conceive of it.[1] It is implicit that different linguistic communities conceive of simple things and processes in the world differently (different cultures), not necessarily some difference between a person's conceptual world and the real world (wrong beliefs).

The main tenets of cognitive semantics are:

- That grammar manifests a conception of the world held in a culture;
- That knowledge of language is acquired and contextual;
- That the ability to use language draws upon general cognitive resources and not a special language module.[1]

As part of the field of cognitive linguistics, the cognitive semantics approach rejects the traditional separation of linguistics into phonology, morphology, syntax, pragmatics, etc. Instead, it divides semantics into *meaning-construction* and *knowledge representation*. Therefore, cognitive semantics studies much of the area traditionally devoted to pragmatics as well as semantics.

The techniques native to cognitive semantics are typically used in lexical studies such as those put forth by Leonard Talmy, George Lakoff, Dirk Geeraerts, and Bruce Wayne Hawkins. Some cognitive semantic frameworks, such as that developed by Talmy, take into account syntactic structures as well.

TOP

Points of contrast

As a field, semantics is interested in three big questions: what does it mean for units of language, called lexemes, to have "meaning"? What does it mean for sentences to have meaning? Finally, how is it that meaningful units fit together to compose complete sentences? These are the main points of inquiry behind studies into lexical semantics, structural semantics, and theories of compositionality (respectively). In each category, traditional theories seem to be at odds with those accounts provided by cognitive semanticists.

Classic theories in semantics (in the tradition of Alfred Tarski and Donald Davidson) have tended to explain the meaning of parts in terms of *necessary and sufficient conditions*, sentences in terms of *truth-conditions*, and composition in terms of *propositional functions*. Each of these positions is tightly related to the others. According to these traditional theories, the meaning of a particular sentence may be understood as the conditions under which the proposition conveyed by the sentence hold true. For instance, the expression "snow is white" is true if and only if snow is, in fact, white. Lexical units can be understood as holding meaning either by virtue of set of things they may apply to (called the "extension" of the word), or in terms of the common properties that hold between these things (called its "intension"). The intension provides an interlocutor with the necessary and sufficient conditions that let a thing qualify as a member of some lexical unit's extension. Roughly, propositional functions are those abstract instructions that guide the interpreter in taking the free variables in an open sentence and filling them in, resulting in a correct understanding of the sentence as a whole.

Meanwhile, cognitive semantic theories are typically built on the argument that lexical meaning is conceptual. That is, meaning is not necessarily reference to the entity or relation in some real or possible world. Instead, meaning corresponds with a concept held in the mind based on personal understanding. As a result, semantic facts like "All bachelors are

unmarried males" are not treated as special facts about our language practices; rather, these facts are not distinct from encyclopaedic knowledge. In treating linguistic knowledge as being a piece with everyday knowledge, the question is raised: how can cognitive semantics explain paradigmatically semantic phenomena, like category structure? Set to the challenge, researchers have drawn upon theories from related fields, like cognitive psychology and cognitive anthropology. One proposal is to treat in order to explain category structure in terms of *nodes* in a *knowledge network*. One example of a theory from cognitive science that has made its way into the cognitive semantic mainstream is the theory of prototypes, which cognitive semanticists generally argue is the cause of polysemy.[citation needed]

Cognitive semanticists argue that truth-conditional semantics is unduly limited in its account of full sentence meaning. While they are not on the whole hostile to truth-conditional semantics, they point out that it has limited explanatory power. That is to say, it is limited to indicative sentences, and does not seem to offer any straightforward or intuitive way of treating (say) commands or expressions. By contrast, cognitive semantics seeks to capture the full range of grammatical moods by also making use of the notions of framing and mental spaces.

Another trait of cognitive semantics is the recognition that meaning is not fixed but a matter of construal and conventionalization. The processes of linguistic construal, it is argued, are the same psychological processes involved in the processing of encyclopaedic knowledge and in perception. This view has implications for the problem of compositionality. An account in cognitive semantics called the dynamic construal theory makes the claim that words themselves are without meaning: they have, at best, "default construals," which are really just ways of using words. Along these lines, cognitive semantics argues that compositionality can only be intelligible if pragmatic elements like context and intention are taken into consideration.[1]

The structure of concepts

Cognitive semantics has sought to challenge traditional theories in two ways: first, by providing an account of the meaning of sentences by going beyond truth-conditional accounts; and second, by attempting to go beyond accounts of word meaning that appeal to necessary and sufficient conditions. It accomplishes both by examining the structure of concepts.

TOC | Previous | Next

Frame semantics

Main article: Frame semantics (linguistics)

Frame semantics, developed by Charles J. Fillmore, attempts to explain meaning in terms of their relation to general *understanding*, not just in the terms laid out by truth-conditional semantics. Fillmore explains meaning in general (including the meaning of lexemes) in terms of *"frames"*. By "frame" is meant any concept that can only be understood if a larger system of concepts is also understood.

TOC | Next

Fillmore: framing

Many pieces of linguistic evidence motivate the frame-semantic project. First, it has been noted that word meaning is an extension of our bodily and cultural experiences. For example, the notion of *restaurant* is associated with a series of concepts, like *food, service, waiters, tables, and eating*.[1] These rich-but-contingent associations cannot be captured by an analysis in terms of necessary and sufficient conditions, yet they still seem to be intimately related to our understanding of "restaurant".

Second, and more seriously, these conditions are not enough to account for asymmetries in the ways that words are used. According to a semantic feature analysis, there is nothing more to the meanings of "boy" and "girl" than:

1. BOY [+MALE], [+YOUNG]
2. GIRL [+FEMALE], [+YOUNG]

And there is surely some truth to this proposal. Indeed, cognitive semanticists understand the instances of the concept held by a given certain word may be said to exist in a *schematic relation* with the concept itself. And this is regarded as a legitimate approach to semantic analysis, so far as it goes.

However, linguists have found that language users regularly apply the terms "boy" and "girl" in ways that go beyond mere semantic features. That is, for instance, people tend to be more likely to consider a young female a "girl" (as opposed to "woman"), than they are to consider a borderline-young male a "boy" (as opposed to "man").[1] This fact suggests that there is a latent frame, made up of cultural attitudes, expectations, and background assumptions, which is part of word meaning. These background assumptions go up and beyond those necessary and sufficient conditions that correspond to a semantic feature account. Frame semantics, then, seeks to account for these puzzling features of lexical items in some systematic way.

Third, cognitive semanticists argue that truth-conditional semantics is incapable of dealing adequately with some aspects of the meanings at the level of the sentence. Take the following:

1. You didn't spare me a day at the seaside; you deprived me of one.

In this case, the truth-conditions of the claim expressed by the antecedent in the sentence are not being denied by the proposition expressed after the clause. Instead, what is being denied is the way that the antecedent is framed.[1]

Finally, with the frame-semantic paradigm's analytical tools, the linguist is able to explain a wider range of semantic phenomena than they would be able to with only necessary and sufficient conditions. Some words have the same definitions or intensions, and the same extensions, but have subtly different domains. For example, the lexemes *land* and *ground* are synonyms, yet they naturally contrast with different things -- *sea* and *air*,

respectively.[1]

As we have seen, the frame semantic account is by no means limited to the study of lexemes—with it, researchers may examine expressions at more complex levels, including the level of the sentence (or, more precisely, the utterance). The notion of framing is regarded as being of the same cast as the pragmatic notion of *background assumptions*. Philosopher of language John Searle explains the latter by asking readers to consider sentences like "The cat is on the mat". For such a sentence to make any sense, the interpreter makes a series of assumptions: i.e., that there is gravity, the cat is parallel to the mat, and the two touch. For the sentence to be intelligible, the speaker supposes that the interpreter has an idealized or default frame in mind.

TOC | Previous | Next

Langacker: profile and base

An alternate strain of Fillmore's analysis can be found in the work of Ronald Langacker, who makes a distinction between the notions of *profile* and *base*. The profile is the concept symbolized by the word itself, while the base is the encyclopedic knowledge that the concept presupposes. For example, let the definition of "radius" be "a line segment that joins the center of a circle with any point on its circumference". If all we know of the concept *radius* is its profile, then we simply know that it is a line segment that is attached to something called the "circumference" in some greater whole called the "circle". That is to say, our understanding is fragmentary until the base concept of *circle* is firmly grasped.

When a single base supports a number of different profiles, then it can be called a "*domain*". For instance, the concept profiles of *arc, center, and circumference* are all in the domain of *circle*, because each uses the concept of *circle* as a base. We are then in a position to characterize the notion of a frame as being either the base of the concept profile, or (more generally) the domain that the profile is a part of.[1]

TOC | Previous | Next

Categorization and cognition

Main article: Prototype theory

A major divide in the approaches to cognitive semantics lies in the puzzle surrounding the nature of category structure. As mentioned in the previous section, semantic feature analyses fall short of accounting for the frames that categories may have. An alternative proposal would have to go beyond the minimalistic models given by classical accounts, and explain the richness of detail in meaning that language speakers attribute to categories.

Prototype theories, investigated by Eleanor Rosch, have given some reason to suppose that many natural lexical category structures are graded, i.e., they have prototypical members that are considered to be "better fit" the category than other examples. For instance, robins are generally viewed as better examples of the category " bird" than, say, penguins. If this view of category structure is the case, then categories can be understood to have central and peripheral members, and not just be evaluated in terms of members and non-members.

In a related vein, George Lakoff, following the later Ludwig Wittgenstein, noted that some categories are only connected to one another by way of *family resemblances*. While some classical categories may exist, i.e., which are structured by necessary and sufficient conditions, there are at least two other kinds: *generative* and *radial*.

Generative categories can be formed by taking central cases and applying certain principles to designate category membership. The principle of similarity is one example of a rule that might generate a broader category from given prototypes.

Radial categories are categories motivated by conventions, but not predictable from rules. The concept of "mother", for example, may be explained in terms of a variety of conditions that may or may not be sufficient. Those conditions may include: being married, has always been female, gave birth to the child, supplied half the child's genes, is a caregiver, is married to the genetic father, is one generation older than the

child, and is the legal guardian.[2] Any one of the above conditions might not be met: for instance, a "single mother" does not need to be married, and a "surrogate mother" does not necessarily provide nurturance. When these aspects collectively cluster together, they form a prototypical case of what it means to be a mother, but nevertheless they fail to outline the category crisply. Variations upon the central meaning are established by convention by the community of language users.

For Lakoff, prototype effects can be explained in large part due to the effects of idealized cognitive models. That is, domains are organized with an ideal notion of the world that may or may not fit reality. For example, the word "bachelor" is commonly defined as "unmarried adult male". However, this concept has been created with a particular ideal of what a bachelor is like: an adult, uncelibate, independent, socialized, and promiscuous. Reality might either strain the expectations of the concept, or create false positives. That is, people typically want to widen the meaning of "bachelor" to include exceptions like "a sexually active seventeen-year-old who lives alone and owns his own firm" (not technically an adult but seemingly still a bachelor), and this can be considered a kind of straining of the definition. Moreover, speakers would tend to want to exclude from the concept of *bachelor* certain false positives, such as those adult unmarried males that don't bear much resemblance to the ideal: i.e., the Pope, or Tarzan.[2] Prototype effects may also be explained as a function of either basic-level categorization and typicality, closeness to an ideal, or stereotyping.

So viewed, prototype theory seems to give an account of category structure. However, there are a number of criticisms of this interpretation of the data. Indeed, Rosch and Lakoff, themselves chief advocates of prototype theory, have emphasized in their later works that the findings of prototype theory do not necessarily tell us anything about category structure. Some theorists in the cognitive semantics tradition have challenged both classical and prototype accounts of category structure by proposing the dynamic construal account, where category structure is always created "on-line"—and so, that categories have no structure outside of the context of use.

Mental spaces

Main article: Mental space

In traditional semantics, the meaning of a sentence is the situation it represents, and the situation can be described in terms of the possible world that it would be true of. Moreover, sentence meanings may be dependent upon propositional attitudes: those features that are relative to someone's beliefs, desires, and mental states. The role of propositional attitudes in truth-conditional semantics is controversial.[3] However, by at least one line of argument, truth-conditional semantics seems to be able to capture the meaning of belief-sentences like "Frank believes that the Red Sox will win the next game" by appealing to propositional attitudes. The meaning of the overall proposition is described as a set of abstract conditions, wherein Frank holds a certain propositional attitude, and the attitude is itself a relationship between Frank and a particular proposition; and this proposition is the possible world where the Red Sox win the next game.[4]

Still, many theorists have grown dissatisfied with the inelegance and dubious ontology behind possible-worlds semantics. An alternative can be found in the work of Gilles Fauconnier. For Fauconnier, the meaning of a sentence can be derived from "mental spaces". Mental spaces are cognitive structures entirely in the minds of interlocutors. In his account, there are two kinds of mental space. The *base space* is used to describe reality (as it is understood by both interlocutors). *Space builders* (or *built space*) are those mental spaces that go beyond reality by addressing possible worlds, along with temporal expressions, fictional constructs, games, and so on.[1] Additionally, Fauconnier semantics distinguishes between *roles* and *values*. A semantic role is understood to be description of a category, while values are the instances that make up the category. (In this sense, the role-value distinction is a special case of the type-token distinction.)

Fauconnier argues that curious semantic constructions can be explained

handily by the above apparatus. Take the following sentence:

1. In 1929, the lady with white hair was blonde.

The semanticist must construct an explanation for the obvious fact that the above sentence is not contradictory. Fauconnier constructs his analysis by observing that there are two mental spaces (the present-space and the 1929-space). His *access principle* supposes that "a value in one space can be described by the role its counterpart in another space has, even if that role is invalid for the value in the first space".[1] So, to use the example above, the value in 1929-space is *the blonde*, while she is being described with the role of *the lady with white hair* in present-day space.

Conceptualization and construal

Main article: Construal

As we have seen, cognitive semantics gives a treatment of issues in the construction of meaning both at the level of the sentence and the level of the lexeme in terms of the structure of concepts. However, it is not entirely clear what cognitive processes are at work in these accounts. Moreover, it is not clear how we might go about explaining the ways that concepts are actively employed in conversation. It appears to be the case that, if our project is to look at *how* linguistic strings convey different semantic content, we must first catalogue *what* cognitive processes are being used to do it. Researchers can satisfy both requirements by attending to the *construal operations* involved in language processing—that is to say, by investigating the ways that people *structure their experiences* through language.

Language is full of conventions that allow for subtle and nuanced conveyances of experience. To use an example that is readily at hand, framing is all-pervasive, and it may extend across the full breadth of linguistic data, extending from the most complex utterances, to tone, to word choice, to expressions derived from the composition of morphemes. Another example is *image-schemata*, which are ways that we structure and understand the elements of our experience driven by any given sense.

According to linguists William Croft and D. Alan Cruse, there are four broad cognitive abilities that play an active part in the construction of construals. They are: attention/ salience, judgment/comparison, situatedness, and constitution/ gestalt.[1] Each general category contains a number of subprocesses, each of which helps to explain the ways we encode experience into language in some unique way.

TOC Previous Next

See also

- Force dynamics
- Image schema
- Cognitive linguistics
- Conceptual role semantics
- Frame semantics
- Construction grammar

TOC Previous

References

1. ^ a b c d e f g h i j k *Croft, William and D. Alan Cruse (2004). Cognitive Linguistics. Cambridge: Cambridge University Press. pp. 1,105,7–15,33–39.*
2. ^ a b *Lakoff, George (1987). Women, Fire, and Dangerous Things. University of Chicago Press. pp. 82–83, 70.*
3. ^ *Bunnin, Nicholas and E. P. Tsui-James. The Blackwell Companion to Philosophy. Oxford: Blackwell. p. 109.*
4. ^ *Fodor, Jerry. Propositional Attitudes.*

Categories:

- Cognitive science
- Semantics
- Cognitive linguistics

This page was last edited on 6 May 2018, at 06:57.

Contents

Number Form

Jump to navigation Jump to search

> *This article refers to the neurological phenomenon. For Unicode numbers, see Number Forms.*

A **number form** is a mental map of numbers, which automatically and involuntarily appears whenever someone who experiences number-forms thinks of numbers. Numbers are mapped into distinct spatial locations and the mapping may be different across individuals. Number forms were first documented and named by Sir Francis Galton in his *The Visions of Sane Persons* (Galton 1881a). Later research has identified them as a type of synesthesia (Seron, Pesenti & Noël 1992; Sagiv et al. 2006).

TOP

TOC Next

Neural mechanisms

It has been suggested that number-forms are a result of "cross-activation" between regions of the parietal lobe that are involved in numerical cognition and angular gyrus for spatial cognition (Ramachandran & Hubbard 2001; Hubbard et al. 2005). Since the areas that process numerical and spatial representations are close to each other, this may contribute to the increased cross-activation. Compared to non-synesthetes, synesthetes display larger P3b amplitudes for month cues, but similar N1 and P3b responses for arrow (<- or ->) and word (left or right) cues. (Teuscher et al. 2010).

TOC Previous Next

Reaction time research

Reaction time studies have shown that number-form synesthetes are faster to say which of two numbers is larger when the numbers are arranged in a manner consistent with their number-form, suggesting that number forms are automatically evoked (Sagiv et al. 2006; Piazza et al.). This can be thought of as a "spatial Stroop" task, in which space is not relevant to the task, but which can hinder performance despite its irrelevance. The fact that synesthetes cannot ignore the spatial arrangement of the numbers on the screen demonstrates that numbers are automatically evoking spatial cues. The reaction times for valid cues are smaller than invalid cues (words and arrows), but in synesthetes the response time differences for months are larger than those of non-synesthetes (Teuscher et al. 2010).

Differences with number line

These number forms can be distinguished from the non-conscious mental number line that we all have by the fact that they are 1) conscious, 2) idiosyncratic (see image) and 3) stable across the lifespan. Although this form of synesthesia has not been as intensively studied as Grapheme → color synesthesia, Hubbard and colleagues have argued that similar neural mechanisms might be involved, but acting in different brain regions (Hubbard et al. 2005). Future studies will need to be conducted to test this hypothesis.

TOC Previous Next

See also

- Synesthesia
- Ideasthesia

TOC Previous

References

- *Ernest, Paul (1986), "Mental number line images" (PDF), Teaching Mathematics and its applications, **5** (1): 1–2, doi: 10.1093/teamat/5.1.1*

- *Galton, F. (1881a), The Visions of Sane Persons*

- *Galton, F. (1881b), "Visualised numerals" (PDF), Journal of the Anthropological Institute, **10**: 85–102, doi: 10.2307/2841651*

- *Hubbard, E. M.; Pinel, P.; Piazza, M.; Dehaene, S. (2005), "Interactions between numbers and space in parietal cortex" (PDF), Nature Reviews Neuroscience, **6**: 435–448, doi: 10.1038/nrn1684, PMID 15928716*

- *Piazza, M.; Pinel, P.; Dehaene, S. (2006), "Objective correlates of a peculiar subjective experience: a single-case study of number-form synaesthesia. Cognitive Neuropsychology", Cognitive Neuropsychology, **23**: 1162–1173, doi: 10.1080/02643290600780080*

- *Ramachandran, V. S.; Hubbard, E. M. (2001), "Synaesthesia: A window into perception, thought and language" (PDF), Journal of Consciousness Studies, **8** (12): 3–34, archived from the original (PDF) on 2006-05-27*

- *Sagiv, N.; Simner, J.; Collins, J.; Butterworth, B.; Ward, J. (2006), "What is the relationship between synaesthesia and visuo-spatial number forms?", Cognition, **101** (101): 114–128, doi: 10.1016/j.cognition.2005.09.004, PMID 16288733*

- *Seron, X.; Pesenti, M.; Noël, M.-P. (1992), "Images of numbers, or When 98 is upper left and 6 sky blue", Cognition, **44**: 159–196, doi: 10.1016/0010-0277(92)90053-K, PMID 1511585*

- *Teucher, U.; Brang, D.; Ramachandran, V.; Coulson, D. (2010), "Spatial cueing in time-space synesthetes: An event-related brain potential study", Brain and Cognition,* ***74*** *(74): 35–46, doi: 10.1016/j.bandc.2010.06.001, PMID 20637536*

Categories:

- Synesthesia
- Cognitive science

This page was last edited on 27 February 2018, at 08:06.

Back to main TOC

Contents

Body Schema

Jump to navigation Jump to search

Body schema is a concept used in several disciplines, including psychology, neuroscience, philosophy, sports medicine, and robotics. The neurologist Sir Henry Head originally defined it as a postural model of the body that actively organizes and modifies 'the impressions produced by incoming sensory impulses in such a way that the final sensation of [body] position, or of locality, rises into consciousness charged with a relation to something that has happened before'.[1] As a postural model that keeps track of limb position, it plays an important role in control of action. It involves aspects of both central (brain processes) and peripheral (sensory, proprioceptive) systems. Thus, a body schema can be considered the collection of processes that registers the posture of one's body parts in space. The schema is updated during body movement. This is typically a non-conscious process, and is used primarily for spatial organization of action. It is therefore a pragmatic representation of the body's spatial properties, which includes the length of limbs and limb segments, their arrangement, the configuration of the segments in space, and the shape of the body surface.[2][3][4][5] Body schema also plays an important role in the integration and use of tools by humans.[6][7][8][9]

A clear differentiation of body schema from body image has developed gradually.

TOP

TOC Next

History

Henry Head, an English neurologist who conducted pioneering work into the somatosensory system and sensory nerves, together with British neurologist Gordon Morgan Holmes, first described the concept in 1911.[10] The concept was first termed "postural schema" to describe the disordered spatial representation of patients following damage to the parietal lobe of the brain. Head and Holmes discussed two schemas (or schemata): one body schema for the registration of posture or movement and another body schema for the localization of stimulated locations on the body surface. "Body schema" became the term used for the "organized models of ourselves".[10] The term and definition first suggested by Head and Holmes has endured nearly a century of research with clarifications as more has become known about neuroscience and the brain.[2]

TOC | Previous | Next

Properties

Neuroscientists Patrick Haggard and Daniel Wolpert have identified seven fundamental properties of the body schema. It is spatially coded, modular, adaptable, supramodal, coherent, interpersonal, and updated with movement.[2]

TOC Previous Next

Spatial encoding

The body schema represents both position and configuration of the body as a 3-dimensional object in space. A combination of sensory information, primarily tactile and visual, contributes to the representation of the limbs in space.[2][4] This integration allows for stimuli to be localized in external space with respect to the body.[6] An example by Haggard and Wolpert shows the combination of tactile sensation of the hand with information about the joint angles of the arm, which allow for rapid movements of said arm to swat a fly.[2]

TOC Previous Next

Modular

The body schema is not represented wholly in a single region of the brain.[2] Recent fMRI (functional Magnetic Resonance Imaging) studies confirm earlier results. For example, the schema for feet and hands are coded by different regions of the brain, while the fingers are represented by a separate part entirely.[11]

TOC Previous Next

Adaptable

Plastic changes to the body schema are active and continuous. For example, gradual changes to the body schema must occur over the lifetime of an individual as he or she grows and absolute and relative sizes of body

parts change over his or her life span.[2] The development of the body schema has also been shown to occur in young children. One study showed that with these children (9-, 14-, and 19-month-olds), older children handled spoons so as to optimally and comfortably grip them for use, whereas younger children tended to reach with their dominant hand, regardless of the orientation of the spoon and eventual ease of use.[12] Short-term plasticity has been shown with the integration of tools into the body schema.[7][9] The rubber hand illusion has also shown the rapid reorganization of the body schema on the timescale of seconds, showing the high level of plasticity and speed with which the body schema reorganizes.[13] In the Illusion, participants view a dummy hand being stroked with a paintbrush, while their own hand is stroked identically. Participants may feel that the touches on their hand are coming from the dummy hand, and even that the dummy hand is, in some way, their own hand.

Supramodal

By its nature, body schema integrates proprioceptive, (the sense of the relative position of neighbouring parts of one's body), and tactile information to maintain a three-dimensional body representation. However, other sensory information, particularly visual, can be in the same representation of the body. This simultaneous participation means there are combined representations within the body schema, which suggests the involvement of a process to translate primary information (e.g. visual, tactile, etc.) into a single sensory modality or an abstract, amodal form. [2]

Coherent

The body schema, to function properly, must be able to maintain coherent organization continuously.[2] To do so, it must be able to resolve any differences between sensory inputs. Resolving these inter-sensory inconsistencies can result in interesting sensations, such as those

experienced during the Rubber Hand Illusion.[13]

TOC Previous Next

Interpersonal

It is thought that an individual's body schema is used to represent both one's own body and the bodies of others. Mirror neurons are thought to play a role in the interpersonal characteristics of body schema. Interpersonal projection of one's body schema plays an important role in successfully imitating motions such as hand gestures, especially while maintaining the handedness and location of the gesture, but not necessarily copying the exact motion itself.[11]

TOC Previous Next

Updated with movement

A working body schema must be able to interactively track the movements and positions of body parts in space.[2] Neurons in the premotor cortex may contribute to this function. A class of neuron in the premotor cortex is multisensory. Each of these multisensory neurons responds to tactile stimuli and also to visual stimuli. The neuron has a tactile receptive field (responsive region on the body surface) typically on the face, arms, or hands. The same neuron also responds to visual stimuli in the space near the tactile receptive field. For example, if a neuron's tactile receptive field covers the arm, the same neuron will respond to visual stimuli in the space near the arm. As shown by Graziano and colleagues, the visual receptive field will update with arm movement, translating through space as the arm moves.[14][15] Similar body-part-centered neuronal receptive fields relate to the face. These neurons apparently monitor the location of body parts and the location of nearby objects with respect to body parts. Similar neuronal properties may also be important for the ability to incorporate external objects into the body schema, such as in tool use.

TOC Previous Next

Extended Body Schema

The idea of the extended body schema is that, aside from the proprioceptive, visual, and sensory components that contribute to making a mental conception of one's body, the same processes that contribute to a body schema are also able to incorporate external objects into the mental conception of one's body. [16] Part philosophical and part neuroscience, this concept builds upon the ideas of plasticity and adaptation to attempt to answer the question of where the body schema ends.

There is debate as to whether this concept truly exists, with one side arguing that the body schema does not extend past the body and the other side believing otherwise.[17][18]

TOC Previous Next

Supporting Arguments

The perspective shared by those who agree with the theory of the extended body schema follow reasoning in line with such that supports theories on tool use.

In some studies, attempts at understanding tool assimilation are used to argue for the existence of the extended body schema. In an experiment involving the use and interaction with wool objects, subjects were tested on their ability to perceive afterimages of wool objects in varying contexts. Subjects accustomed their eyes to a dark room and then were shown a brief (1 millisecond) flash of light, intending to produce an afterimage effect of their arms which they held out in front of them during the experiment. Moving an arm afterwards would make the afterimage "fade" or disappear as it moved, thus indicating that the feature (the arm) was being tracked and integrated into the person's body schema. To test integration of the meaningless wool objects, subjects experienced four different contexts.

1. Subjects held the wool objects in each hand and one hand (the active hand) would move, still holding the object (the active object).
2. Using the active hand, the active wool object would be dropped once

an afterimage was perceived.

3. Using the active hand, one would grab the active wool object once an afterimage was perceived.
4. The subjects were to hold onto a mechanical device which held the wool object. Once an afterimage was perceived, a subject's active hand would cause the mechanical device to drop the wool object.

In all situations but the fourth, the subjects experienced the same "fading" effect as they did with their arm alone. This would thus indicate that the wool objects had been integrated into their body schema and contributes support towards the idea of the body's using proprioceptive and visual elements to create an extended body schema. The mechanical device acted as an intermediate between the subject and the active object, and the subjects' failure to detect an afterimage in that context indicates that this concept of extension is limited to being sensitive to only what the body is directly in contact with.[19]

Dissenting Arguments

The alternate perspective is that the body is the limit of any sort of body schema.

An example of this division is found in a study and discussion on personal and extrapersonal attention, where personal relates to the body's sense of itself (the body schema) and extrapersonal relates to all external of such. Some research supports the claim that these two categories are purely distinct and do not intermingle, contrary to what the extended body schema theory describes. Evidence for such is primarily found in subjects with unilateral neglect, such as in the case of E.D.S., who was a middle-aged man with right hemisphere brain damage. When he was tested for hemispatial neglect using traditional measures such as sentence reading and cancellation tests, E.D.S. showed few signs and upon later examination showed no signs whatsoever, leading doctors to believe he was normal. However, he constantly had issues with physical therapy

because he would claim to not be able to see his left leg; upon further examination, E.D.S. was known to have a particular type of hemispatial neglect that only affected the perception of his body. The motor function of the left side of his body was negatively affected though not totally compromised, yet when attempting tasks such as shaving, he would invariably not shave the left side of his face. This led some researchers to believe that there is a distinction between personal and extrapersonal neglect, which would thus reflect a similar distinction with body schema itself.[20]

Associated disorders

TOC Previous Next

Deafferentation

The most direct of related disorders, deafferentation occurs when sensory input from the body is reduced or absent, without affecting efferent, or motor, neurons. The most famous case of this disorder is "IW", who lost all sensory input from below the neck, resulting in temporary paralysis. He was forced to learn to control his movement all over again using only his conscious body image and visual feedback. As a result, when constant visual input is lost during an activity, such as walking, it becomes impossible for him to complete the task, which may result in falling, or simply stopping. IW requires constant attention to tasks to be able to complete them accurately, demonstrating how automatic and subconscious the process of integrating touch and proprioception into the body schema actually is.[21]

TOC Previous Next

Autotopagnosia

Autotopagnosia typically occurs after left parietal lesions. Patients with this disorder make errors which result from confusion between adjacent body parts. For example, a patient may point to their knee when asked to point to their hip. Because the disorder involves the body schema, localization errors may be made both on the patient’s own body and that of others. The spatial unity of the body within the body schema has been damaged such that it has incorrectly been segmented in relation to its other modular parts.[22]

TOC Previous Next

Phantom limb

Phantom limbs are a phenomenon which occurs following amputation

of a limb from an individual. In 90–98% of cases, amputees report feeling all or part of the limb or body part still there, taking up space.[23] The amputee may perceive a limb under full control, or paralyzed. A common side effect of phantom limbs is phantom limb pain. The neurophysiological mechanisms by which phantom limbs occur is still under debate.[24] A common theory posits that the afferent neurons, since deafferented due to amputation, typically remap to adjacent cortical regions within the brain. This can cause amputees to report feeling their missing limb being touched when a seemingly unrelated part of the body is stimulated (such as if the face is touched, but the amputee also feels their missing arm being stroked in a specific location). Another facet of phantom limbs is that the efferent copy (motor feedback) responsible for reporting on position to the body schema does not attenuate quickly. Thus the missing body part may be attributed by the amputee to still be in a fixed or movable position.[2]

Tool use

Not only is it necessary for the body schema to be able to integrate and form a three-dimensional representation of the body, but it also plays an important role in tool use.[9] Studies recording neuronal activity in the intraparietal cortex in macaques have shown that, with training, the macaque body schema updates to include tools, such as those used for reaching, into the body schema.[9] In humans, body schema plays an important role in both simple and complex tool use, far beyond that of macaques.[6][8][9] Extensive training is also not necessary for this integration.[11]

The mechanisms by which tools are integrated into the body schema are not fully understood. However, studies with long-term training have shown interesting phenomena. When wielding tools in both hands in a crossed posture, behavioral effects reverse in a similar way to when only hands are crossed. Thus, sensory stimuli are delivered the same way be it to the hands directly or indirectly via the tools. These studies suggest the mind incorporates the tools into the same or similar areas as it does the adjacent hands.[9] Recent research into the short term plasticity of the body schema used individuals without any prior training with tools. These results, derived from the relation between afterimages and body schema, show that tools are incorporated into the body schema within seconds, regardless of length of training, though the results do not extend to other species besides humans.[6]

TOC Previous Next

Confusion with body image

Historically, body schema and body image were generally lumped together, used interchangeably, or ill-defined. In science and elsewhere, the two terms are still commonly misattributed or confused. Efforts have been made to distinguish the two and define them in clear and differentiable ways.[25] A body image consists of perceptions, attitudes, and beliefs concerning one's body. In contrast, body schema consists of sensory-motor capacities that control movement and posture.

Body image may involve a person’s conscious perception of his or her own physical appearance. It is how individuals see themselves when picturing themselves in their mind, or when perceiving themselves in a mirror. Body image differs from body schema as perception differs from movement. Both may be involved in action, especially when learning new movements.

TOC Previous Next

See also

- Body image (medicine)
- Peripheral neuropathy
- Schema (psychology)

TOC Previous

References

1. ^ *Head, H. (1920). Studies in Neurology. Vol 2. London: Oxford University Press.*
2. ^ a b c d e f g h i j k *Haggard, P.; D. Wolpert (2005). "Disorders of body schema". High-order motor disorders: from neuroanatomy and neurobiology to clinical neurology. Oxford University Press. pp. 261–271. ISBN 0-19-852576-1.*
3. ^ *Holmes, N.; C. Spence (2004). "The body schema and the multisensory representation(s) of peripersonal space". Cognitive processing.* ***5*** *(2): 94–105. doi:10.1007/s10339-004-0013-3. PMC 1350799 . PMID 16467906.*
4. ^ a b *Macaluso, E. & A. Maravita (2010). "The representation of space near the body through touch and vision". Neuropsychologia.* ***48*** *(3): 782–795. doi:10.1016/j.neuropsychologia.2009.10.010. PMID 19837101.*
5. ^ *Maravita, A.; C. Spence; J. Driver (2003). "Multisensory integration and the body schema: close to hand and within reach". Current Biology.* ***13*** *(13): R531–R539. doi:10.1016/S0960-9822(03)00449-4. PMID 12842033.*
6. ^ a b c d *Berti, A.; F. Frassinetti (2000). "When far becomes near: Remapping of space by tool use". Journal of Cognitive Neuroscience.* ***12*** *(3): 415–420. doi:10.1162/089892900562237. PMID 10931768.*
7. ^ a b *Carlson, T.; et al. (2010). "Rapid Assimilation of External Objects Into the Body Schema". Psychological Science.* ***21*** *(7): 1000–5. doi:10.1177/0956797610371962. PMID 20483818.*
8. ^ a b *Johnson-Frey, S. (2004). "The neural bases of complex tool use in humans". Trends in Cognitive Sciences.* ***8*** *(2): 71–78. doi:10.1016/j.tics.2003.12.002. PMID 15588811.*
9. ^ a b c d e f g *Maravita, A.; A. Iriki (2004). "Tools for the body (schema)". Trends in Cognitive Sciences.* ***8*** *(2): 79–86. doi:10.1016/j.tics.2003.12.008. PMID 15588812.*
10. ^ a b *Head, H.; G. Holmes (1911). "Sensory disturbances from cerebral lesions". Brain.* ***34*** *(2–3): 102. doi:10.1093/brain/34.2-3.102.*

11. ^ a b c *Chaminade, T.; A. Meltzoff & J. Decety (2005). "An fMRI study of imitation: action representation and body schema". Neuropsychologia. **43** (1): 115–127. doi:10.1016/j.neuropsychologia.2004.04.026. PMC 3648209 . PMID 15488911.*
12. ^ *Johnson, S. (2000). "Thinking ahead: the case for motor imagery in prospective judgements of prehension". Cognition. **74** (1): 33–70. doi:10.1016/S0010-0277(99)00063-3. PMID 10594309.*
13. ^ a b *Lewis, E.; D. M. Lloyd (2010). "Embodied experience: A first-person investigation of the rubber hand illusion". Phenomenology and the Cognitive Sciences. **9** (3): 317–339. doi:10.1007/s11097-010-9154-2.*
14. ^ *Graziano, M.S.A.; Hu, X.T. & Gross, C.G (1997). "Coding the locations of objects in the dark". Science. **277** (5323): 239–241. doi:10.1126/science.277.5323.239. PMID 9211852.*
15. ^ *Graziano, M.S.A.; Yap, G.S. & Gross, C.G (1994). "Coding of visual space by premotor neurons". Science. **266**: 1054–1057. doi:10.1126/science.7973661. PMID 7973661.*
16. ^ Aglioti et al., 1996. Disownership of left hand and objects related to it in a patient with right brain damage. NeuroReport. 8:293-296.
17. ^ Reed, C. L., & Farah, M. J. (1995). The psychological reality of the body schema: A test with normal participants. Journal of Experimental Psychology: Human Perception and Performance, 21(2), 334-343.
18. ^ Yamamoto and Kitazawa. 2011. Reversal of subjective temporal order due to arm crossing. Nature Neuroscience 4: 759-765
19. ^ Carlson et al. 2010. Rapid Assimilation of External Objects Into the Body Schema. *Psychological Science*. 21(7):1000-1005
20. ^ Guariglia and Antonucci. 1992. Personal and extrapersonal space: A case of neglect dissociation. Neuropsychologia, 30:1001-1009
21. ^ *Gallagher, S.; J. Cole (1995). "Body schema and body image in a deafferented subject". Journal of Mind and Behavior. **16** (4): 369–390. Retrieved 16 June 2012.*
22. ^ *Sirigu, A.; et al. (1991). "Multiple representations contribute to body knowledge processing: Evidence from a case of autotopagnosia". Brain. **114** (1): 629. doi:10.1093/brain/114.1.629.*
23. ^ *Ramachandran, V.S.; W. Hirstein (1998). "The perception of*

phantom limbs. The D. O. Hebb lecture". Brain. ***121*** *(9): 1603–30. doi:10.1093/brain/121.9.1603. PMID 9762952.*

24. ^ *Giummarra, M.; et al. (2007). "Central mechanisms in phantom limb perception: the past, present and future". Brain Research Reviews.* ***54*** *(1): 219–232. doi:10.1016/j.brainresrev.2007.01.009. PMID 17500095.*
25. ^ *Gallagher, S. (2006). How the body shapes the mind. Oxford University Press, USA. ISBN 0-19-920416-0.*

Categories:

- Motor cognition
- Motor control
- Cognitive science

This page was last edited on 12 May 2018, at 00:28.

Back to main TOC

Contents

Sensory Cue

Jump to navigation Jump to search

A **sensory cue** is a statistic or signal that can be extracted from the sensory input by a perceiver, that indicates the state of some property of the world that the perceiver is interested in perceiving.

A cue is some organization of the data present in the signal which allows for meaningful extrapolation. For example, sensory cues include visual cues, auditory cues, haptic cues, olfactory cues, environmental cues, and so on. Sensory cues are a fundamental part of theories of perception, especially theories of appearance (how things look).

TOP

TOC Next

Concept

There are two primary theory sets used to describe the roles of sensory cues in perception. One set of theories are based on the Constructivist theory of perception, while the others are based on the Ecological theory.

Basing his views on the Constructivist theory of perception, Helmholtz (1821-1894) held that the visual system constructs visual percepts through a process of *unconscious inference*, in which cues are used to make probabilistic inferences about the state of the world. These inferences are based on prior experience, assuming that the most commonly correct interpretation of a cue will continue to hold true.[1] A visual percept is the final manifestation of this process. Brunswik (1903-1955) later went on to formalize these concepts with the *lens model*, which breaks the system's use of a cue into two parts: the ecological validity of the cue, which is its likelihood of correlating with a property of the world, and the system's *utilization* of the cue.[2] In these theories, accurate perception requires both the existence of cues with sufficiently high ecological validity to make inference possible, and that the system actually utilizes these cues in an appropriate fashion during the construction of percepts.

A second set of theories was posited by Gibson (1904-1979), based on the Ecological theory of perception. These theories held that no inferences are necessary to accomplish accurate perception. Rather, the visual system is able to take in sufficient cues related to objects and their surroundings. This means that a one:one mapping between the incoming cues and the environment they represent can be made. These mappings will be shaped by certain computational constraints; traits known to be common in an organism's environment.[3] The ultimate result is the same: a visual precept is manifested by the process.

Cue combination is an active area of research in perception, that seeks to understand how information from multiple sources is combined by the brain to create a single perceptual experience or response. Recent cue recruitment experiments have shown that the adult human visual system

can learn to utilize new cues through classical (Pavlovian) conditioning.

TOC Previous Next

Visual Cues

Visual cues are sensory cues received by the eye in the form of light and processed by the visual system during visual perception. Since the visual system is dominant in many species, especially humans, visual cues are a large source of information in how the world is perceived.[4]

TOC Previous Next

Types of cues

TOC Next

Depth

Main article: Depth perception

The ability to perceive the world in three dimensions and estimate the size and distance to an object depends heavily on depth cues. The two major depth cues, Stereopsis and motion parallax, both rely on parallax which is the difference between the perceived position of an object given two different viewpoints. In stereopsis the distance between the eyes is the source of the two different viewpoints, resulting in a Binocular disparity. Motion parallax relies head and body movement to produce the necessary viewpoints.[5]

TOC Previous Next

Motion

Main article: Motion perception

The visual system can detect motion both using a simple mechanism based on information from multiple clusters of neurons as well as by aggregate through by integrating multiple cues including contrast, form, and texture. One major source of visual information when determining self-motion is optic flow. Optic flow not only indicates whether an agent is moving but

in which direction and at what relative speed.

Biological Motion

Main article: Biological motion

Humans in particular have evolved a particularly keen ability to detect if motion is being generated by biological source, even with **point light displays** where dots representing the joints of an animal.[6] Recent research suggests that this mechanism can also reveal the gender, emotional state, and action of a given human light point model.[7]

Color

Main article: Color vision

The ability to distinguish between colors allows an organism quickly and easily recognize danger since many brightly colored plants and animals pose some kind of threat, usually harboring some kind of toxin. Color also serves as an inferential cue that can prime both motor action[8] and interpretation of a persuasive message.[9]

Contrast

Main article: Contrast (vision)

Contrast, or the difference in luminance and/or color that helps make an object distinguishable, is important in edge detection and serves as a cue.

Auditory Cues

An auditory cue is a sound signal that represents an incoming sign received through the ears, causing the brain to hear. The results of receiving and processing these cues are collectively known as the sense of hearing, and are the subject of research within the fields of psychology, cognitive science, and neurobiology.

TOC Previous Next

Auditory System

Main article: Hearing

The auditory system of humans and animals allows individuals to assimilate information from the surroundings, represented as sound waves. Sound waves first pass through the pinnae and the auditory canal, the parts of the ear that comprise the outer ear. Sound then reaches the tympanic membrane in the middle ear (also known as the eardrum). The tympanic membrane sets the malleus, incus, and stapes into vibration. The stapes transmits these vibrations to the inner ear by pushing on the membrane covering the oval window, which separates the middle and inner ear. The inner ear contains the cochlea, the liquid-filled structure containing the hair cells. These cells serve to transform the incoming vibration to electrical signals, which can then be transmitted to the brain. The auditory nerve carries the signal generated by the hair cells away from the inner ear and towards the auditory receiving area in the cortex. The signal then travels through fibers to several subcortical structures and then to the primary auditory receiving area in the temporal lobe

TOC Previous Next

Cues for Sound Locating

Humans use several cues to determine the location of a given stimuli,

mainly by using the timing difference between ears. These cues allow individuals to identify both the elevation, the height of the stimuli relative to the individual, and azimuth, the angle of the sound relative to the direction the individual is facing.

TOC Previous Next

Interaural Time and Level Difference

Unless a sound is directly in front of or behind the individual, the sound stimuli will have a slightly different distance to travel to reach each ear. This difference in distance causes a slight delay in the time the signal is perceived by each ear. The magnitude of the interaural time difference is greater the more the signal comes from the side of the head. Thus, this time delay allows humans to accurately predict the location of incoming sound cues. Interaural level difference is caused by the difference in sound pressure level reaching the two ears. This is because the head blocks the sound waves for the further ear, causing less intense sound to reach it. This level difference between the two ears allows humans to accurately predict azimuth of an auditory signal. This effect only occurs at sounds that are high frequency.

TOC Previous Next

Spectral Cue

A spectral cue is a monoaural (single ear) cue for locating incoming sounds based on the distribution of the incoming signal. The differences in distribution (or spectrum) of the sound waves are caused by sounds interaction with the head and the outer ear before entering the ear canal.

TOC Previous Next

Principles of Auditory Cue Grouping

The auditory system uses several heuristics to make sense of incoming cues, based on the properties of auditory stimuli that usually occur in the environment. Cue grouping refers to how humans naturally perceive incoming stimuli as organized patterns, based on certain rules.

TOC Previous Next

Onset Time

If two sounds start at different times, they are likely to have originated from different sources. Sounds that originate simultaneously likely come from the same source.

TOC Previous Next

Location

Cues originating at the same, or slowly changing, positions usually have the same source. When two sounds are separated in space, the cue of location (see: sound localization) helps an individual to separate them perceptually. If a sound is moving, it will move continuously. Erratically jumping sound is unlikely to come from the same source.

TOC Previous Next

Similarity of Timbre

Timbre is the tone quality or tone character of a sound, independent of pitch. This helps us distinguish between musical instruments playing the same notes. When hearing multiple sounds, the timbre of each sound will be unchanging (regardless of pitch), and thus we can differentiate between sounds from different sources over time.[10]

TOC Previous Next

Similarity of Pitch

Pitch refers to the frequency of the sound wave reaching us. Although a single object could produce a variety of pitches overtime, it more likely that it would produce sounds in a similar range. Erratic changes in pitches are more likely to be perceived as originating from different sources.

TOC Previous Next

Auditory Continuity

Similar to the Gestalt principle of good continuation (see: principles of grouping), sound that changes smoothly or remain constant are often produced by the same source. Sound with the same frequency, even when interrupted by other noise, is perceived as continuous. Highly variable sound that is interrupted is perceived as separate.[11]

Factors Effecting Auditory Cue Perception

The Precedence Effect

When one sound is presented for a long interval before the introduction of a second one originating from a different location, individuals will hear them as two distinct sounds, each originating from the correct location. However, when the delay between the onset of the first and second sound is shortened, listeners are unable to distinguish between the two sounds. Instead, they perceive them as both coming from the location of the lead sound. This effect counteracts the small disparity between the perception of sound caused by the difference in distance between each ear and the source of the auditory stimuli.

The Interaction between Auditory and Visual Cues

There are strong interactions between visual and auditory stimuli. Since both auditory and visual cues provide an accurate source of information about the location of an object, most times there will be minimal discrepancy between the two. However, it is possible to have a disparity in the information provided by the two sets of cues. Visual capture, also known as the ventriloquism effect, occurs when an individual's visual system locates the source of an auditory stimulus at a different position than where the auditory system locates it. When this occurs, the visual cues will override the auditory ones. The individual will perceive the sound as coming from the location where the object is seen. Audition can also affect visual perception. Research has demonstrated this effect by showing two

objects on a screen, one moving diagonally from top-right to bottom-left and the other from top-left to bottom-right, intersecting in the middle. The paths of these identical objects could have been interpreted as crossing over each other, or as bouncing off each other. Without any auditory cue, a vast majority of subjects saw the objects crossing paths and continuing in their original trajectory. But with the addition of a small “click” sound, a majority of subjects perceived the objects as bouncing off each other. In this case, auditory cues help interpret visual cues.[12]

TOC Previous Next

Haptic Cues

A haptic cue is either a tactile sensation that represents an incoming signal received by the somatic system, or a relationship between tactile sensations which can be used to infer a higher level of information.[13] The results of receiving and processing these cues are collectively known as the sense of touch, and are the subject of research in the fields of psychology, cognitive science, and neurobiology.

The word “haptic” can refer explicitly to active exploration of an environment (particularly in experimental psychology and physiology), but is often used to refer to the whole of the somesthetic experience.[14]

TOC Previous Next

Somatosensory System

Main article: Somatosensory system

The somatosensory system assimilates many kinds of information from the environment: temperature, texture, pressure, proprioception, and pain. The signals vary for each of these perceptions, and the receptor systems reflect this: Thermoreceptors, mechanoreceptors, nociceptors, and chemoreceptors.

TOC Previous Next

Haptic Cues in Research

TOC Previous Next

The Interaction between Haptic and Visual Cues

In addition to the interplay of haptic communication and nonverbal communication, haptic cues as primers have been looked at as a means of decreasing reaction time for identifying a visual stimulus.[15] Subjects were placed in a chair fitted with a back which provided haptic cues

indicating where the stimulus would appear on a screen. Valid haptic cues significantly decreased reaction time while invalid cues increased reaction time.[15]

TOC Previous

Use in Technology for the Visually Impaired

Haptic cues are used frequently to allow those who have impaired vision to have access to a greater wealth of information. Braille is a tactile written language which is read via touch, brushing the fingers over the raised patterns. Braille technology is the attempt to extend Braille to digital media and developing new tools to aid in the reading of web pages and other electronic devices often involves a combination of haptic and auditory cues.[16]

A major issue that different technologies in this area attempt to overcome is sensory overload. The amount of information that can be quickly related via touch is less than that of vision and is limited by current technology. As a result, multi-modal approaches, converting the visual information into both haptic and auditory output, often have the best results. For example, an electronic pen can be drawn across a tablet mapped to the screen and produce different vibrations and sounds depending on what is at that location.[16]

TOC Previous Next

Olfactory Cues

An olfactory cue is a chemical signal received by the olfactory system that represents an incoming signal received through the nose. This allows humans and animals to smell the chemical signal given off by a physical object. Olfactory cues are extremely important for sexual reproduction, as they trigger mating behavior in many species, as well as maternal bonding and survival techniques such as detecting spoiled food. The results of receiving and processing this information is known as the sense of smell.

TOC Previous Next

Olfactory System

Main article: Olfactory System

The process of smelling begins when chemical molecules enter the nose and reach the olfactory mucosa, a dime-sized region located in the nasal cavity that contains olfactory receptor neurons. There are 350 types of olfactory receptors, each sensitive to a narrow range of odorants. These neurons send signals to the glomeruli within the olfactory bulb. Each glomerulus collects information from a specific olfactory receptor neuron. The olfactory signal is then conducted to piriform cortex and the amygdala, and then to the orbitalfrontal cortex, where higher level processing of the odor occurs.

TOC Previous Next

Olfactory Memory

Main article: Olfactory Memory

Olfactory memory is the recollection of a given smell. Research has found that odor memory is highly persistent and has a high resistance to interference, meaning these memories remain within an individual for long times despite possible interference of other olfactory memories. These

memories are mostly explicit, though implicit forms of odor memory do provide some understanding of memory. Mammalian olfactory cues play an important role in the coordination of the mother infant bond, and the following normal development of the offspring. Olfactory memory is especially important for maternal behavior. Studies have shown that the fetus becomes familiar with olfactory cues in the within the uterus. This is demonstrated by research that suggests that newborns respond positively to the smell of their own amniotic fluid, meaning that fetuses learn from these cues in the womb.[17]

Environmental Cues

Environmental cues are all of the sensory cues that exist in the environment.

With directed attention an environmental cue becomes an attended cue.[13] However, most environmental cues are assimilated subconsciously, as in visual contextual cueing.

Environmental cues serve as the primary context that shapes how the world is perceived and as such they can prime prior experience to influence memory recall[18] and decision making.[19] This has applied use in marketing as there is evidence to suggest a store's atmosphere and layout can influence purchasing behavior.[20]

Environmental cues play a direct role in mediating the behavior of both plants[21] and animals. For example, environmental cues, such as temperature change or food availability affect the spawning behavior of fish. In addition to cues generated by the environment itself, cues generated by other agents, such as ant pheromone trails, can influence behavior to indirectly coordinate actions between those agents.

In the study of perception environmental cues play a large role in experimental design since these mechanisms evolved within a natural environment[22] which gives rise to scene statistics and the desire to create a natural scene. If the experimental environment is too artificial it can damage external validity in an ideal observer experiment that makes use of natural scene statistics.

See also

- Environmental Context Dependent Memory
- Stimulus (psychology)

TOC Previous

References

1. ^ Rogers, edited by William Epstein, Sheena (1995). *Perception of space and motion*. San Diego: Academic Press. pp. 3–5. ISBN 0080538614.
2. ^ Rogers, edited by William Epstein, Sheena (1995). *Perception of space and motion*. San Diego: Academic Press. pp. 5–7. ISBN 0080538614.
3. ^ Rogers, edited by William Epstein, Sheena (1995). *Perception of space and motion*. San Diego: Academic Press. pp. 7–9. ISBN 0080538614.
4. ^ Posner, Michael I.; Nissen, Mary J.; Klein, Raymond M. (March 1976). "Visual dominance: An information-processing account of its origins and significance". *Psychological Review*. **83** (2): 157–171. doi:10.1037/0033-295X.83.2.157.
5. ^ Steinman, Scott B.; Garzia, Ralph Philip (2000). *Foundations of Binocular Vision: A Clinical perspective*. McGraw-Hill Professional. pp. 2–5. ISBN 0-8385-2670-5.
6. ^ G. Johansson (1973). "Visual perception of biological motion and a model for its analysis". *Percept. Psychophys*. **14** (2): 201–211. doi:10.3758/BF03212378.
7. ^ Alaerts, Kaat; Nackaerts, Evelien; Meyns, Pieter; Swinnen, Stephan P.; Wenderoth, Nicole; Valdes-Sosa, Mitchell (June 9, 2011). "Action and Emotion Recognition from Point Light Displays: An Investigation of Gender Differences". *PLoS ONE*. **6** (6): e20989. doi:10.1371/journal.pone.0020989. PMC 3111458 . PMID 21695266.
8. ^ Schmidt, T.: *The finger in flight: Real-time motor control by visually masked color stimuli.* In: *Psychological Science*, Nr. 13, 2002, S. 112-118.
9. ^ Gerend, Mary A.; Sias, Tricia (July 2009). "Message framing and color priming: How subtle threat cues affect persuasion". *Journal of Experimental Social Psychology*. **45** (4): 999–1002. doi:10.1016/j.jesp.2009.04.002.
10. ^ Bregman, Albert (1971). "Primary Auditory Stream Segregation and Perception of Order in Rapid Sequences of Tones". *Journal of Experimental Psychology*. **89** (2): 244–249. doi:10.1037/h0031163. PMID 5567132.
11. ^ Warren, R. M.; Obusek, C. J.; Ackroff, J. M. (9 June 1972). "Auditory Induction: Perceptual Synthesis of Absent Sounds". *Science*. **176** (4039): 1149–1151. doi:10.1126/science.176.4039.1149.
12. ^ Sekuler, Robert; Sekuler, Allison B.; Lau, Renee. "Sound alters visual motion perception". *Nature*. **385** (6614): 308–308. doi:10.1038/385308a0.
13. ^ ***a b*** Goldstein, Bruce E. (2007). *Sensation and Perception*. Cengage Learning. pp. 5–6. ISBN 978-0-495-60149-4.
14. ^ Robles-De-La-Torre, G. (1 July 2006). "The Importance of the Sense of Touch in Virtual and

Real Environments". *IEEE Multimedia*. **13** (3): 24–30. doi:10.1109/MMUL.2006.69.
15. ^ *a b* "Validity of Haptic Cues and Its Effect on Priming Visual Spatial Attention" (PDF). 2003. doi:10.1109/HAPTIC.2003.1191265.
16. ^ *a b* Jay, Caroline; Stevens, Robert; Hubbold, Roger; Glencross, Mashhuda (1 May 2008). "Using haptic cues to aid nonvisual structure recognition". *ACM Transactions on Applied Perception*. **5** (2): 1–14. doi:10.1145/1279920.1279922.
17. ^ Varendi, H; Porter, RH; Winberg, J (1 September 1997). "Natural odour preferences of newborn infants change over time". *Acta Paediatrica*. **86** (9): 985–990. doi:10.1111/j.1651-2227.1997.tb15184.x.
18. ^ Godden, D; Baddeley, A. (1975). "Context dependent memory in two natural environments". *British Journal of Psychology*. **66** (3): 325–331. doi:10.1111/j.2044-8295.1975.tb01468.x.
19. ^ Elder, Ryan S.; Krishna, Aradhna (2010). "The Effects of Advertising Copy on Sensory Thoughts and Perceived Taste". *Journal of Consumer Research*. **36** (5): 748–56. doi:10.1086/605327.
20. ^ Baker, Julie; Parasuraman, A.; Grewal, Dhruv; Voss, Glenn B. (1 April 2002). "The Influence of Multiple Store Environment Cues on Perceived Merchandise Value and Patronage Intentions". *Journal of Marketing*. **66** (2): 120–141. doi:10.1509/jmkg.66.2.120.18470.
21. ^ Berger, Jonah A.; Heath, Chip (March–April 2010). "Idea Habitats: How the Prevalence of Environmental Cues Influences the Success of Ideas". *Cognitive Science*. **29** (2): 195–221. doi:10.1207/s15516709cog0000_10.
22. ^ Geisler, W. S.; Diehl, R. L. (2003). "A Bayesian approach to the evolution of perceptual and cognitive systems". *Cognitive Science*. **27**: 379–402. doi:10.1016/s0364-0213(03)00009-0.

Categories: Perception | Sensory systems | Psychology | Visual perception | Cognitive science

Contents

Number Sense

Jump to navigation Jump to search

In mathematics education, **number sense** can refer to "an intuitive understanding of numbers, their magnitude, relationships, and how they are affected by operations".[1] Other definitions of number sense emphasize an ability to work outside of the traditionally taught algorithms, e.g., "a well organised conceptual framework of number information that enables a person to understand numbers and number relationships and to solve mathematical problems that are not bound by traditional algorithms".[2]

Psychologists believe that the number sense in humans can be differentiated into the approximate number system, a system that supports the estimation of the magnitude, and the parallel individuation system, which allows the tracking of individual objects, typically for quantities below 4.[3]

There are also some differences in how number sense is defined in math cognition. For example, Gersten and Chard say number sense "refers to a child's fluidity and flexibility with numbers, the sense of what numbers mean and an ability to perform mental mathematics and to look at the world and make comparisons."[4][5][6]

In non-human animals, number sense is not the ability to count, but the ability to perceive changes in the number of things in a collection.[7] All mammals, and most birds, will notice if there is a change in the number of their young nearby. Many birds can distinguish two from three.[8] In humans, small children around fourteen months of age are also able to notice something that is missing from a group that they are familiar with.[*citation needed*]

Researchers consider number sense to be of prime importance for children in early elementary education, and the National Council of Teachers of

Mathematics has made number sense a focus area of pre-K through 2nd grade mathematics education.[9] An active area of research is to create and test teaching strategies to develop children's number sense. Number sense also refers to the contest hosted by the University Interscholastic League. This contest is a ten-minute test where contestants solve math problems mentally—no calculators, scratch-work, or mark-outs are allowed.[10]

Concepts involved in number sense

The term *"number sense"* involves several concepts of magnitude, ranking, comparison, measurement, rounding, percents, and estimation, including:[11]

- estimating with large numbers to provide reasonable approximations;
- judging the degree of precision appropriate to a situation;
- rounding (understanding reasons for rounding large numbers and limitations in comparisons);
- choosing measurement units to make sense for a given situation;
- solving real-life problems involving percentages and decimal portions;
- comparing physical measurements within and between the U.S. and metric systems; and
- comparing degrees Fahrenheit and Celsius in real-life situations.[11]

Those concepts are taught in elementary-level education.

TOC Previous Next

See also

- Approximate number system
- Parallel individuation system
- Mental calculation
- Number sense in animals
- Numeracy, innumeracy
- Numerosity adaptation effect
- Order of magnitude
- Numerals and grammatical number of the Pirahã language
- Rounding error

TOC Previous Next

References

1. ^ *"number sense"*.
2. ^ *"What is number sense?"*.
3. ^ *Piazza, M. (2010). "Neurocognitive start-up tools for symbolic number representations". Trends in Cognitive Sciences.* ***14****: 542–551. doi:10.1016/j.tics.2010.09.008.*
4. ^ *"Number Sense: Rethinking Arithmetic Instruction for Students with Mathematical Disabilities"*.
5. ^ *"Making Sense of Number Sense: Implications for Children With Mathematical Disabilities"*.
6. ^ *"Stages in Development of Number Sense - Harvard Education Letter"*.
7. ^ *"Number Systems"*. *www.math.twsu.edu.*
8. ^ Dantzig, Tobias. Number: The Language of Science. New York: Macmillan Company, 1930.
9. ^ *"Understanding a Child's Development of Number Sense"*.
10. ^ *"UIL Number Sense"*.
11. ^ [a] [b] "Unit 1: Number and Number Sense" (20-day lesson), STPSB.org, St. Tammany Parish School Board, Covington, LA (USA), 2009, overview webpage: ST-MathGrade7Unit-topics.

TOC Previous

External links

- Number Worlds - a site with number sense development materials

Categories:

- Cognitive science
- Educational psychology

This page was last edited on 7 May 2018, at 21:41.

Back to main TOC

Contents

Multiple Realizability

Jump to navigation Jump to search

Multiple realizability, in the philosophy of mind, is the thesis that the same mental property, state, or event can be implemented by different physical properties, states, or events. The idea has its roots in the late 1960s and early 1970s when a number of philosophers, most prominently Hilary Putnam and Jerry Fodor, put it forth as an argument against reductionist accounts of the relation between mental and physical kinds.[1] In short, a theory of mind that includes multiple realizability allows for the existence of strong AI. The original targets of these arguments were the type-identity theory and eliminative materialism. The same arguments from multiple realizability were also used to defend many versions of functionalism, especially *Machine state functionalism*.

In recent years, however, multiple realizability has been used to attack the very theory that it was originally designed to defend. As a result, functionalism has fallen out of favor as a dominant theory in the philosophy of mind.[*citation needed*] The dominant theory ("received view" in the words of Lepore and Pylyshyn) in modern philosophy of mind is a version of generic non-reductive physicalism[*citation needed*] and one of its central pillars is the hypothesis of multiple realizability.

Complicating our historical understanding, Restrepo noted in 2009 that the thesis of the multiple realizability of the mental was held by Turing at least ten years before the usually attributed authors described the phenomenon.[2] In 1950, Turing expressed the multiple realizability of the mental in the following:

TOP

TOC Next

Putnam's formulation

In several papers published in he late 1960s, Hilary Putnam provides a classic example of the thesis of multiple realizability. In these papers, he argues that, contrary to type-identity theory, it is not the case that "pain is identical to C-fibre firing." Pain corresponds to, or is at least correlated with, completely different physical states of the nervous system in different organisms and yet they all experience the same mental state of "being in pain." Putnam cited numerous examples from all over the animal kingdom to illustrate his thesis. Is it likely that the brain structures of all mammals, reptiles, birds, amphibians and molluscs realize pain, or other mental states, in exactly the same way? Do they even have the same brain structures? Clearly not, if we believe the evidence furnished by comparative neuroanatomy and neurophysiology. How can they possibly share the same mental states and properties? The answer must be that these mental kinds are realized by different physical states in different species. Putnam then takes his argument a step further, and asks about such things as the nervous systems of alien beings, artificially-intelligent robots and silicon-based life forms. Should such hypothetical entities be considered *a priori* incapable of experiencing pain just because they do not possess the same neurochemistry as humans? Putnam concludes that type-identity and other reductive theorists make an extremely "ambitious" and "highly implausible" conjecture which can be disproved with just one example of multiple realizability. This argument is referred to as *the likelihood argument*.

Putnam also formulates a complementary argument based on, what he calls, *functional isomorphism*. He defines the concept in these terms: "Two systems are functionally isomorphic if *there is a correspondence between the states of one and the states of the other that preserves functional relations*." So, in the case of computers, two machines are functionally isomorphic if and only if the sequential relations among states in the first are exactly mirrored by the sequential relations among states in the second. Therefore, a computer made out of silicon chips and a computer made out of cogs and wheels can be functionally isomorphic but constitutionally

diverse. Functional isomorphism implies multiple realizability. This is referred to as the "a priori argument".

Jerry Fodor, Putnam and others also note that, along with being a very effective argument against type-identity theories, multiple realizability implies that *any* low-level explanation of higher-level mental phenomena would be insufficiently abstract and general. Functionalism, which attempts to identify mental kinds with functional kinds that are characterized exclusively in terms of causes and effects, abstracts from the physico-chemical level of microphysics and hence seems to be a more suitable alternative explanation of the relation between mind and body. In fact, there are many functional kinds such as mousetraps, software and bookshelves that are multiply realized at the physical level.

TOC | Previous | Next

Fodor's generalization

Jaegwon Kim takes up the challenge of responding to the problems posed by multiple realizability for reductionist theories by suggesting that the physical realization base of a particular mental state is not a particular physical state but the disjunction of the physical states which realize it. Jerry Fodor replies to this objection by formulating a generalization of the multiple realizability thesis. According to Fodor, multiple realizability is not just something that occurs "across physical structure-types" but is a phenomenon that could occur even within the same token system (such as an organism). At different times, the same organism may realize type-identical mental kinds in physically different forms. (This thesis was later given some empirical support with the discovery of the relative plasticity of the human brain).

Fodor uses this generalized multiple realizability thesis to argue against reductionism of the mind and of the special sciences. The key to Fodor's argument is that, in his characterization of reductionism, all mental kind predicates in an ideal and completed psychology must correspond with a physical kind predicate in an ideal and completed physics. He suggests taking Ernest Nagel's theory of reduction, which insists on the derivability of all terms in the theory to be reduced from terms in the reducing theory and the bridging laws, as the canonical theory of reduction. Given generalized multiple realizability, the physical science part of these psychophysical bridge laws will end up being a (possibly infinite) disjunction of all the terms referring to possible physical realizations of a mental kind. This disjunction cannot be a kind-predicate and therefore the entire statement cannot be a law of physics. The special sciences cannot be reduced to physics in this way, according to Fodor.

In 1988, Hilary Putnam applied the argument from Fodor's generalized version of multiple realizability to argue against functionalism itself, including, and above all, his own version of functionalism, machine state functionalism. Noting that functionalism is essentially a watered-down reductionist or identity theory in which mental kinds are ultimately

identified with functional kinds, Putnam argues that mental kinds are probably multiply realizable over functional kinds. The same mental state or property can be implemented or realized by different states of a universal Turing machine.

TOC Previous Next

Objections and responses

Early objections to multiple realizability were limited to the narrow, "across structures-type" version. Starting with David Kellogg Lewis, many reductionists argued that it is very common, perhaps the rule, in actual scientific practice to reduce one theory to another by way of "local" and structure-specific reductions. A frequently cited example of this sort of intertheoretic reduction is the case of temperature from classical thermodynamics. Temperature is identical to mean molecular kinetic energy, but this is only true of *temperature in a gas*. Temperature in a solid is identical to mean *maximal* molecular kinetic energy, because the molecules of a solid are more restricted in their movements. Temperature in a plasma is something of a mystery, since the molecules of a plasma are torn apart. Therefore, temperature, in classical thermodynamics is multiply realized in a wide diversity of microphysical states.

One common defense of multiple realizability argues that any such response which attempts to address the problem of the possibility of *generalized* multiple realizability must necessarily be so "local" and "context" specific in nature, referring exclusively to a certain token system of a certain structure-type at a certain time, that its reductions would be incompatible with even a minimally acceptable degree of generality in scientific theorizing. This problem is well illustrated by the controversial question of the plasticity of the human brain. Simply put, neural plasticity consists in the fact that different areas of the brain can, and often do, take over the functions of other parts that have been damaged as the result of traumatic injury, pathology, natural biological development and other processes. Any psychology which is narrowed down sufficiently to handle this level of multiple realizability will almost certainly not be general enough to capture the generalizations needed to explain only human psychology.

Recent reductionists (including Bechtel and Mundale) reply that this is not empirically plausible. In order to conduct research and carry out experiments in the neurosciences, some universal consistencies in brain structures must either exist or be assumed to exist. The similarity

(produced by homology or convergent evolution) of brain structures allows us to generalize across species. If multiple realizability (especially the generalized form) were an empirical fact, then results from experiments conducted on one species of animal (or one organism) would not be meaningful or useful when generalized to explain the behavior or characteristics of another species (or organism of the same species; or in the generalized form, even the same organism).

Sungsu Kim has recently responded to this objection by pointing to the important distinction between homology of brain structures and homoplasy. Homologies are any characteristics of physiology, morphology, behavior or psychology that are shared by two or more species and that are inherited from a common ancestor. Homoplasies are similar or identical characteristics that are shared by two or more species but that are not inherited from a common ancestor, having evolved independently. The feet of ducks and platypuses are a good example of homoplasy, while the hands of humans and chimps are a good example of homology. The fact that brain structures are homologous provides no evidence either for or against multiple realizability. The only way to empirically test the thesis of multiple realizability would be to examine brain structures and determine whether some homoplasious "psychological processes or functions might be 'constructed' from different material" and supported by different brain structures just as the flight capacities of bats and birds emerge from different morphophysiologies. The emergence of similar behavioral outputs or psychological functions brought about by similar or identical brain structures in convergent evolutionary lineages would provide some evidence against multiple realizability, since it is highly improbable that this would happen, if not for constraints on the type of physical system that can realize mental phenomena. This, however, would not completely refute the possibility of realizibility of mental states in radically different physical systems such as non-carbon based life forms or machines.

TOC Previous Next

Kim's argument

Jaegwon Kim has recently argued against non-reductive physicalism on the grounds that it violates the causal closure of the physical. The rough idea is that physics provides a full explanation of physical events. If mental properties are causally efficacious, they must either be identical to physical properties, or there must be widespread overdetermination. The latter is often held to be either unlikely or even impossible on conceptual grounds. If Kim is right, then the options seem to be either reduction or elimination.

TOC Previous Next

Medium Independence

In his mechanistic account of computation, Gualtiero Piccinini appeals to the notion of medium independence. To understand this, we must first differentiate three related qualities: variable realizability, multiple realizability, and medium independence. A property is said to be variably realizable if it can be instantiated by different realizers. For a property to be multiply realizable, the property must be able to be instantiated by different realizers and different mechanisms. For example, consider a winged corkscrew and a waiter's corkscrew. Both have the property of removing corks and do so through the same mechanism - a screw and pull mechanism. Because the mechanism is fundamentally unchanged, the property is variably realizable. Next, consider the property of trapping mice as instantiated by mousetraps. Consider the classic spring mousetrap and the glue mousetrap. Both instantiate the same property, the ability to trap mice, but they do so through different mechanisms. As such, the property is multiply realizable. Medium independence has an criteria over and above those of multiple realizablity. A property is medium independent if it can be instantiated by differnt realizers and different mechanisms and if the inputs and outputs of the mechanisms are also multiply realizable. As you can see, a mousetrap is not medium independent; it must take a mouse as an input. A computer, though, is medium independent. A computer can be constructed from different parts assembled into different mechanisms and, importantly, can take different types of inputs and outputs. In typical digital computers, the inputs and outputs are voltages, but in quantum computers, the inputs and outputs would be different. [4]

References

1. ^ Bickle, J. (2006). Multiple realizability. In Stanford encyclopedia of philosophy. Available at http://plato.stanford.edu/entries/multiple-realizability/. Last revised in 2006, and last checked on May 27, 2009.
2. ^ Restrepo, R. (2009). *Russell's Structuralism and the Supposed Death of Computational Cognitive Science*. Minds and Machines 19(2): 181-197.
3. ^ Turing, A. (1950). Computing machinery and intelligence. Mind 59. In J. Copeland (Ed.), The essential Turing (pp. 433–460). Oxford: Claredon Press, p. 446.
4. ^ *Piccinini, Gualtiero (2015). Physical Computation: A Mechanistic Account. Oxford: Oxford University Press. p. 10. ISBN 9780199658855.*

- Putnam, Hilary. *Representation and Reality*.1988. Cambridge, MA. MIT Press.
- Fodor, Jerry. *The Language of Thought*. 1975. New York. Thomas Cromwell.
- Bechtel, William and Mundale, Jennifer. *Multiple Realizability Revisited* in *Philosophy of Science* 66: 175-207.
- Kim, Sungsu. *Testing Multiple Realizability: A Discussion of Bechtel and Mundale* in *Philosophy of Science*. 69: 606-610.
- Kim, Jaegwon. *Multiple Realizability and the Metaphysics of Reduction* on *Philosophy and Phenomenological Research*. 52: 1-26.
- Shapiro, Lawrence A. *Multiple Realizations*.

Further reading

- Auto Turing test, a test of Multiple Realizability

TOC Previous

External links

- Mind and Multiple Realizability article in the *Internet Encyclopedia of Philosophy*
- 'Multiple Realizability' entry at Stanford Encyclopedia of Philosophy by John Bickle
- PhilPapers bibliography on multiple realizability

Categories:

- Arguments in philosophy of mind
- Cognitive science

This page was last edited on 26 April 2018, at 04:26.

Back to main TOC

Contents

Interaction Theory

Jump to navigation Jump to search

Interaction theory (IT) is an approach to questions about social cognition, or how one understands other people, that focuses on bodily behaviors and environmental contexts rather than on mental processes. IT argues against two other contemporary approaches to social cognition (or what is sometimes called ‘theory of mind’), namely theory theory (TT) and simulation theory (ST). For TT and ST, the primary way of understanding others is by means of ‘mindreading’ or ‘mentalizing’ – processes that depend on either theoretical inference from folk psychology, or simulation. In contrast, for IT, the minds of others are understood primarily through our embodied interactive relations. IT draws on interdisciplinary studies and appeals to evidence developed in developmental psychology, phenomenology (philosophy), and neuroscience.

TOP

TOC Next

Origins

According to Michael et al (2013),[1] “The recent surge of interactionist approaches to social cognition can be traced back to Shaun Gallagher’s proposal for a new approach to social cognition, which he labeled ‘interaction theory’.[2] Gallagher argued that mainstream mindreading approaches neglect the interactive contexts in which social cognition is embedded, and thereby overlook embodied and extended processes that are engaged in interactions, and which are important components of social cognition.” The basic ideas of IT can be traced back to the work of Colwyn Trevarthen[3] who coined the term ‘primary intersubjectivity’ to refer to early developing sensory-motor processes of interaction between infants and caregivers. Other work in developmental psychology by Daniel Stern (psychologist), Andrew N. Meltzoff, Peter Hobson, Vasu Reddy, and others, provides important evidence for the role of interaction in social cognition. Similar insights can be found earlier in the work of the phenomenologists, like Max Scheler and Maurice Merleau-Ponty. IT has also motivated a rethinking in the methods for studying social cognition in neuroscience.[4]

Primary and secondary intersubjectivity

Colwyn Trevarthen [5] coined the term ‘primary intersubjectivity’ to refer to early developing sensory-motor processes of interaction between infants and caregivers. Important cues for understanding others are provided by their facial expressions, bodily posture and movements, gestures, actions, and in processes of neonate imitation, proto-conversations, gaze following and affective attunement. "In most intersubjective situations, that is, in situations of social interaction, we have a direct perceptual understanding of another person’s intentions because their intentions are explicitly expressed in their embodied actions and their expressive behaviors. This understanding does not require us to postulate or infer a belief or a desire hidden away in the other person’s mind. What we might reflectively or abstractly call their belief or desire is expressed directly in their actions and behaviors."[6]

Sometime during the first year of life infants also start to enter into joint attention situations and begin to pay attention to how others act and what they do with objects in everyday contexts, and this also provides a way to understand their intentions and contextualized actions. This is referred to as ‘secondary intersubjectivity’, which highlights the fact that interactions often take place in cooperative contexts.[7] During most interactions, intentions are apparent based upon the pragmatic context of the situation in which they are occurring. We can instantly see what the other “intends” or “wants” based upon their actions and the current context; we do not need to infer their intentions as if they are hidden away. There is a “shared world” that we live in where we intuitively and instinctively perceive others as minded beings like ourselves.

Direct perception

Interaction theory supports the notion of the direct perception of the other's intentions and emotions during intersubjective encounters. Gallagher[8][9] argues that most of what we need for our understanding of others is based on our interactions and perceptions, and that very little mindreading occurs or is required in our day-to-day interactions. Rather than first perceiving another's actions and then inferring the meaning of their actions (as in TT), the intended meaning is perceptible in the other person's movements and contextualized actions. Differences in a person's intentions show up as differences in perceptible kinematic properties of action movements.[10] A person's emotions are not only expressed on their faces and in their postures and gestures, but these perceptible embodied aspects help to constitute what the emotion is. Mental states (like intentions and emotions) are therefore not hidden away from view, they are, IT claims, in fact, and at least in part, bodily states that are apparent in the action movements that constitute them. For example, as phenomenologists from Max Scheler to Dan Zahavi point out, upon seeing an angry face an observer does not first see a face that is contorted into a scowl and then infer that the target is angry. The anger is immediately apparent on the face of the other. The overwhelming majority of interactions in our daily lives are face-to-face so it makes sense that our primary way of understanding one another is from a second-person perspective rather than from the detached, theoretical, third-person perspective described by TT and ST.

Narrative competency

In addition to primary and secondary intersubjectivity, and the contributing dynamics of interaction itself to the social cognitive process,[11] IT proposes that more nuanced and sophisticated understandings of others are based, not primarily on folk psychological theory or the use of simulation, but on the implicit and explicit uses of narrative.[12][13] IT builds on the notion that the pervasiveness of narratives in most cultures, from the earliest nursery rhymes to the performances of theater, film, and television, expose us to a variety of characters, situations, and reasons for acting in certain ways. These, combined with personal narratives, provide the background knowledge that allows us to implicitly frame the actions of others in understandable narratives, providing a fallible and revisable sense of what the other is up to.

TOC Previous

References

1. ^ Michael, J., Christiansen, W., and Overgaard, S. (2013). Mindreading as social expertise. Synthese. DOI 10.1007/s11229-013-0295-z
2. ^ Gallagher, S. (2001). The practice of mind: Theory, simulation, or primary interaction? Journal of Consciousness Studies, 8 (5–7): 83–107
3. ^ Trevarthen, C. B. 1979. Communication and cooperation in early infancy: A description of primary intersubjectivity. In M. Bullowa (ed.), Before Speech. Cambridge: Cambridge University Press
4. ^ Schilbach, L.,Timmermans, B., Reddy, V., Costal, A., Schlicht, T. and Vogeley, K. 2013. Toward a second-person neuroscience. Behavioral and Brain Sciences 36(4): 393-414.
5. ^ Trevarthen, C. B. 1979. Communication and cooperation in early infancy: A description of primary intersubjectivity. In M. Bullowa (ed.), Before Speech. Cambridge: Cambridge University Press
6. ^ Gallagher, S. & Hutto, D. (2008). Understanding others through Primary Interaction and Narrative Practice. In T. Zlatev, T. Racine, C. Sinha, & E. Itkonen, The Shared Mind: Perspectives on Intersubjectivity (pp. 17–38). Amsterdam: John Benjamins
7. ^ Trevarthen, C. and Hubley, P. 1978. Secondary intersubjectivity: Confidence, confiding and acts of meaning in the first year. In A. Lock (ed.), Action, Gesture and Symbol: The Emergence of Language (pp. 183-229). London: Academic Press.
8. ^ Gallagher, S. (2005). How the Body Shapes the Mind. Oxford: Oxford University Press/Clarendon Press
9. ^ Gallagher, S. 2008. Direct perception in the intersubjective context. Consciousness and Cognition 17: 535–543
10. ^ Becchio C., Manera V., Sartori L., Cavallo A., Castiello U. (2012). Grasping intentions: from thought experiments to empirical evidence. Frontiers of Human Neuroscience, 6, 117
11. ^ De Jaegher, H., Di Paolo, E. & Gallagher, S. (2010). Can social interaction constitute social cognition? Trends in Cognitive Sciences, 14 (10), 441-447
12. ^ Gallagher, S. & Hutto, D. (2008). Understanding others through

primary interaction and narrative practice. In T. Zlatev, T. Racine, C. Sinha, & E. Itkonen, The Shared Mind: Perspectives on Intersubjectivity (pp. 17–38). Amsterdam: John Benjamins

13. ^ Hutto, D. Folk Psychological Narratives: The Sociocultural Basis of Understanding Reasons. Cambridge, MA: MIT Press

Categories:

- Cognitive science

This page was last edited on 26 September 2015, at 23:36.

Back to main TOC

Contents

Congruence Bias

Jump to navigation Jump to search

Congruence bias is a type of cognitive bias similar to confirmation bias. Congruence bias occurs due to people's overreliance on directly testing a given hypothesis as well as neglecting indirect testing.

TOP

TOC Next

Examples

Suppose that, in an experimental setting, a subject is presented with two buttons and told that pressing one of those buttons, but not the other, will open a door. The subject adopts the hypothesis that the button on the left opens the door in question. A direct test of this hypothesis would be pressing the button on the left; an indirect test would be pressing the button on the right. The latter is still a valid test because once the result of the door's remaining closed is found, the left button is proven to be the desired button. (This example is parallel to Bruner, Goodnow, and Austin's example in the psychology classic, *A Study of Thinking*.)

It is possible to take this idea of direct and indirect testing and apply it to more complicated experiments in order to explain the presence of a congruence bias in people. In an experiment, a subject will test his own usually naive hypothesis again and again instead of trying to disprove it.

The classic example of subjects' congruence bias was discovered by Peter Wason (1960, 1968). Here, the experimenter gave subjects the number sequence "2, 4, 6", telling the subjects that this sequence followed a particular rule and instructing subjects to find the rule underlying the sequence logic. Subjects provided their own number sequences as tests to see if they could ascertain the rule dictating which numbers could be included in the sequence and which could not. Most subjects respond to the task by quickly deciding that the underlying rule is "numbers ascending by 2", and provide as tests only sequences concordant with this rule, such as "3, 5, 7," or even "pi plus 2, plus 4, plus 6". Each of these sequences follows the underlying rule the experimenter is thinking of, though "numbers ascending by 2" is not the actual criterion being used. However, because subjects succeed at repeatedly testing the same singular principle, they naively believe their chosen hypothesis is correct. When a subject offers up to the experimenter the hypothesis "numbers ascending by 2" only to be told he is wrong, much confusion usually ensues. At this point, many subjects attempt to change the wording of the rule without changing its meaning, and even those who switch to indirect testing have trouble letting go of the "+ 2" convention, producing potential rules as

idiosyncratic as "the first two numbers in the sequence are random, and the third number is the second number plus two". Many subjects never realize that the actual rule the experimenter was using was simply just to list ascending numbers, because of the subjects' inability to consider indirect tests of their hypotheses.

Cognitive basis

Wason attributed this failure of subjects to an inability to consider alternative hypotheses, which is the root of the congruence bias. Jonathan Baron explains that subjects could be said to be using a "congruence heuristic", wherein a hypothesis is tested only by thinking of results that would be found if that hypothesis is true. This heuristic, which many people seem to use, ignores alternative hypotheses.

Baron suggests the following heuristics to avoid falling into the congruence bias trap:

1. Ask "How likely is a yes answer, if I assume that my hypothesis is false?" Remember to choose a test that has a high probability of giving some answer if the hypothesis is true, and a low probability if it is false.
2. "Try to think of alternative hypotheses; then choose a test most likely to distinguish them—a test that will probably give different results depending on which is true." An example of the need for the heuristic could be seen in a doctor attempting to diagnose appendicitis. In that situation, assessing a white blood cell count would not assist in diagnosis, because an elevated white blood cell count is associated with a number of maladies.

TOC | Previous | Next

See also

- List of cognitive biases

References

Bibliography

- *Bruner, Jerome Seymour; Goodnow, Jacqueline J.; Austin, George Allen (1956). A Study of Thinking. Wiley. LCCN 56007999. OL 6199287M.*
- *Wason, P. C. (1960). "On the failure to eliminate hypotheses in a conceptual task". Quarterly Journal of Experimental Psychology.* ***12*** *(3): 129–140. doi: 10.1080/17470216008416717.*
- *Wason, P. C. (1968). "Reasoning about a rule". Quarterly Journal of Experimental Psychology.* ***20*** *(3): 273–281. doi: 10.1080/14640746808400161. PMID 5683766.*

Reference books

- *Baron, Jonathan (2008). Thinking and Deciding (4th ed.). New York: Cambridge University Press. pp. 171–177. ISBN 978-0-521-86207-3.*

Categories:

- Cognitive biases
- Cognition
- Cognitive science

This page was last edited on 12 June 2018, at 21:12.

Contents

Biolinguistics

Jump to navigation Jump to search

Biolinguistics is the study of the biology and evolution of language. It is a highly interdisciplinary field, including linguists, biologists, neuroscientists, psychologists, mathematicians, and others. By shifting the focus of investigation in linguistics to a comprehensive scheme that embraces natural sciences, it seeks to yield a framework by which we can understand the fundamentals of the faculty of language.

TOP

TOC Next

Origins

The biolinguistic perspective began to take shape in the mid-twentieth century, among the linguists influenced by the developments in biology and mathematics.[1] Eric Lenneberg's *Biological Foundations of Language* remains a basic document of the field.[2] In 1974, the first Biolinguistic conference was organized by Massimo Piattelli-Palmarini, bringing together evolutionary biologists, neuroscientists, linguists, and others interested in the development of language in the individual, its origins, and evolution.[3]

TOC | Previous | Next

Developments

Recent work in theoretical linguistics and cognitive studies at MIT construes human language as a highly non-redundant species-specific system. Noam Chomsky's latest contribution to the study of the mind in general and language in particular is his minimalist approach to syntactic representations. This effort to understand how much of language can be given a principled explanation has resulted in the Minimalist Program. In syntax, lexical items are merged externally, building argument representations; next, the internal merge induces movement and creates constituent structures where each is part of a larger unit. This mechanism allows people to combine words into infinite strings. If this is true, then the objective of biolinguists is to find out as much as we can about the principles underlying mental recursion.

TOC Previous Next

Hypothesis

It is possible that the core principles of the language faculty be correlated to natural laws (such as for example, the Fibonacci sequence — an array of numbers where each consecutive number is a sum of the two that precede it, see for example the discussion Uriagereka 1997 and Carnie and Medeiros 2005).[4] According to the hypothesis being developed, the essential properties of language arise from nature itself: the efficient growth requirement appears everywhere, from the pattern of petals in flowers, leaf arrangements in trees and the spirals of a seashell to the structure of DNA and proportions of human head and body. If this law applies to existing systems of cognition, both in humans and non-humans, then what allows our mind to create language? Could it be that a single cycle exists, a unique component of which gives rise to our ability to construct sentences, refer to ourselves and other persons, group objects and establish relations between them, and eventually understand each other? The answer to this question will be a landmark breakthrough, not only within linguistics but in our understanding of cognition in general.

Critiques

David Poeppel, a neuroscientist and linguist, has noted that if neuroscience and linguistics are done wrong, there is a risk of "inter-disciplinary cross-sterilization", arguing that there is a *Granularity Mismatch Problem*, as different levels of representations used in linguistics and neural science lead to vague metaphors linking brain structures to linguistic components. Poeppel and Embick also introduce the *Ontological Incommensurability Problem*, where computational processes described in linguistic theory cannot be restored to neural computational processes. Poeppel suggests that neurolinguistic research should try to have theories of how the brain encodes linguistic information and what could be cognitively realistic computation.[5]

TOC Previous Next

People in biolinguistics

- Marcus Dzanda, Dirksen school
- Michael Arbib, University of Southern California
- Antonio Benítez-Burraco, University of Huelva
- Derek Bickerton, University of Hawaii
- Cedric Boeckx, University of Barcelona
- Andrew Carnie, University of Arizona
- Anna Maria Di Sciullo, University of Quebec at Montreal
- Ray C. Dougherty, New York University (NYU)
- W. Tecumseh Fitch, University of Vienna
- Koji Fujita, Kyoto University
- Marc D. Hauser
- Philip Lieberman, Brown University
- Alec Marantz, NYU/ MIT
- Nirmalangshu Mukherji[6] University of Delhi
- Kazuo Okanoya, University of Tokyo
- Massimo Piatelli-Palmarini, University of Arizona
- David Poeppel, NYU
- Charles Reiss, Concordia University
- Alona Soschen, MIT
- Kenneth Wexler, MIT

See also

- Biosemiotics
- Evolutionary psychology of language
- Neurolinguistics
- Origin of language
- Origin of speech

TOC Previous Next

References

1. ^ *Chomsky, Noam (2004). "Biolinguistics and the Human Capacity. Lecture delivered at MTA, Budapest, May 17, 2004".*
2. ^ Lenneberg, Eric. 1967. *Biological Foundations of Language*. New York: John Wiley & Sons, Inc.
3. ^ *Boeckx, Cedric; Piattelli-Palmarini, Massimo (2005). "Language as a natural object, linguistics as a natural science. Linguistic Review 22: 447–466" (PDF).*
4. ^ Soschen, Alona. 2006. Natural Law: The Dynamics of Syntactic Representations in the Minimalist Program. DEAL. Linguistics in Potsdam 25. *"Archived copy" (PDF). Archived from the original (PDF) on 2007-02-21. Retrieved 2007-02-18.*
5. ^ *Poeppel, David; Embick, David (2005). "Defining the Relation Between Linguistics and Neuroscience". In Anne Cutler. Twenty-First Century Psycholinguistics: Four Cornerstones. Lawrence Erlbaum.*
6. ^ *"Nirmalangshu Mukherji". people.du.ac.in.*

TOC Previous Next

Conferences

- Biolinguistic Investigations Conference, Santo Domingo, Dominican Republic, February 2007.
- Conference on Biolinguistics: Language Evolution and Variation, Università di Venezia, June 2007.
- ICREA International Symposium in Biolinguistics, Universitat de Barcelona, October 2012.
- *The Journal of Biolinguistics*

TOC Previous

External links

- Biolinguistics Journal

Categories:

- Syntax
- Noam Chomsky
- Linguistics
- Cognitive science

This page was last edited on 9 November 2017, at 10:41.

Back to main TOC

Contents

Learning

Jump to navigation Jump to search
"Learn" and "Learned" redirect here. For other uses, see Learn (disambiguation) and Learned (disambiguation).

Learning is the process of acquiring new or modifying existing knowledge, behaviors, skills, values, or preferences.[1] The ability to learn is possessed by humans, animals, and some machines; there is also evidence for some kind of learning in some plants.[2] Some learning is immediate, induced by a single event (e.g. being burned by a hot stove), but much skill and knowledge accumulates from repeated experiences. The changes induced by learning often last a lifetime, and it is hard to distinguish learned material that seems to be "lost" from that which cannot be retrieved.[3]

Human learning begins before birth and continues until death as a consequence of ongoing interactions between person and environment. The nature and processes involved in learning are studied in many fields, including educational psychology, neuropsychology, experimental psychology, and pedagogy. Research in such fields has led to the identification of various sorts of learning. For example, learning may occur as a result of habituation, or classical conditioning, operant conditioning or as a result of more complex activities such as play, seen only in relatively intelligent animals.[4][5] Learning may occur consciously or without conscious awareness. Learning that an aversive event can't be avoided nor escaped may result in a condition called learned helplessness.[6] There is evidence for human behavioral learning prenatally, in which habituation has been observed as early as 32 weeks into gestation, indicating that the central nervous system is sufficiently developed and primed for learning and memory to occur very early on in development.[7]

Play has been approached by several theorists as the first form of learning.

Children experiment with the world, learn the rules, and learn to interact through play. Lev Vygotsky agrees that play is pivotal for children's development, since they make meaning of their environment through playing educational games.

TOP

TOC Next

Types

See also: Learning styles and Machine learning § Types of problems and tasks

TOC Next

Non-associative learning

Non-associative learning refers to "a relatively permanent change in the strength of response to a single stimulus due to repeated exposure to that stimulus. Changes due to such factors as sensory adaptation, fatigue, or injury do not qualify as non-associative learning."[8]

Non-associative learning can be divided into habituation and sensitization.

TOC Next

Habituation

Main article: Habituation

Habituation is an example of non-associative learning in which the strength or probability of a response diminishes when the stimulus is repeated. The response is typically a reflex or unconditioned response. Thus, habituation must be distinguished from extinction, which is an associative process. In operant extinction, for example, a response declines because it is no longer followed by reward. An example of habituation can be seen in small song birds—if a stuffed owl (or similar predator) is put into the cage, the birds initially react to it as though it were a real predator. Soon the birds react less, showing habituation. If another stuffed owl is introduced (or the same one removed and re-introduced), the birds react to it again as though it were a predator, demonstrating that it is only a very specific stimulus that is habituated to (namely, one particular unmoving owl in one place). Habituation has been shown in essentially every species of animal, as well as the sensitive plant *Mimosa pudica*[9]

and the large protozoan *Stentor coeruleus*.[10]

TOC Previous Next

Sensitization

Main article: Sensitization

Sensitization is an example of non-associative learning in which the progressive amplification of a response follows repeated administrations of a stimulus (Bell et al., 1995).[*citation needed*] An everyday example of this mechanism is the repeated tonic stimulation of peripheral nerves that occurs if a person rubs their arm continuously. After a while, this stimulation creates a warm sensation that eventually turns painful. The pain results from the progressively amplified synaptic response of the peripheral nerves warning that the stimulation is harmful.[*clarification needed*] Sensitisation is thought to underlie both adaptive as well as maladaptive learning processes in the organism.[*citation needed*]

TOC Previous Next

Active learning

Main article: Active learning

Active learning occurs when a person takes control of his/her learning experience. Since understanding information is the key aspect of learning, it is important for learners to recognize what they understand and what they do not. By doing so, they can monitor their own mastery of subjects. Active learning encourages learners to have an internal dialogue in which they verbalize understandings. This and other meta-cognitive strategies can be taught to a child over time. Studies within metacognition have proven the value in active learning, claiming that the learning is usually at a stronger level as a result.[12] In addition, learners have more incentive to learn when they have control over not only how they learn but also what they learn.[13] Active learning is a key characteristic of student-centered learning. Conversely, passive learning and direct instruction are

characteristics of teacher-centered learning (or traditional education).

Associative learning

Associative learning is the process by which a person or animal learns an association between two stimuli. In classical conditioning a previously neutral stimulus is repeatedly paired with a reflex eliciting stimulus until eventually the neutral stimulus elicits a response on its own. In operant conditioning, a behavior that is reinforced or punished in the presence of a stimulus becomes more or less likely to occur in the presence of that stimulus.

TOC Previous Next

Operant conditioning

Main article: Operant conditioning

In *operant conditioning*, a reinforcement (by reward) or instead a punishment given after a given behavior, change the frequency and/or form of that behavior. Stimulus present when the behavior/consequence occurs come to control these behavior modifications.

TOC Previous Next

Classical conditioning

Main article: Classical conditioning

The typical paradigm for *classical conditioning* involves repeatedly pairing an unconditioned stimulus (which unfailingly evokes a reflexive response) with another previously neutral stimulus (which does not normally evoke the response). Following conditioning, the response occurs both to the unconditioned stimulus and to the other, unrelated stimulus (now referred to as the "conditioned stimulus"). The response to the conditioned stimulus is termed a *conditioned response*. The classic example is Ivan Pavlov and his dogs. Pavlov fed his dogs meat powder, which naturally made the

dogs salivate—salivating is a reflexive response to the meat powder. Meat powder is the unconditioned stimulus (US) and the salivation is the unconditioned response (UR). Pavlov rang a bell before presenting the meat powder. The first time Pavlov rang the bell, the neutral stimulus, the dogs did not salivate, but once he put the meat powder in their mouths they began to salivate. After numerous pairings of bell and food, the dogs learned that the bell signaled that food was about to come, and began to salivate when they heard the bell. Once this occurred, the bell became the conditioned stimulus (CS) and the salivation to the bell became the conditioned response (CR). Classical conditioning has been demonstrated in many species. For example, it is seen in honeybees, in the proboscis extension reflex paradigm.[14] And recently, it was demonstrated in garden pea plants.[15]

Another influential person in the world of classical conditioning is John B. Watson. Watson's work was very influential and paved the way for B.F. Skinner's radical behaviorism. Watson's behaviorism (and philosophy of science) stood in direct contrast to Freud and other accounts based largely on introspection. Watson's view was that the introspective method was too subjective, and that we should limit the study of human development to directly observable behaviors. In 1913, Watson published the article "Psychology as the Behaviorist Views," in which he argued that laboratory studies should serve psychology best as a science. Watson's most famous, and controversial, experiment, "Little Albert", where he demonstrated how psychologists can account for the learning of emotion through classical conditioning principles.

TOC Previous Next

Observational Learning

Main article: Observational learning

Observational learning is learning that occurs through observing the behavior of others. It is a form of social learning which takes various forms, based on various processes. In humans, this form of learning seems to not need reinforcement to occur, but instead, requires a social model

such as a parent, sibling, friend, or teacher with surroundings.

TOC Previous Next

Imprinting

Main article: Imprinting (psychology)

Imprinting is a kind of learning occurring at a particular life stage that is rapid and apparently independent of the consequences of behavior. In filial imprinting, young animals, particularly birds, form an association with another individual or in some cases, an object, that they respond to as they would to a parent. In 1935, the Austrian Zoologist Konrad Lorenz discovered that certain birds follow and form a bond if the object makes sounds.

TOC Previous Next

Play

Main article: Play (activity)

Play generally describes behavior with no particular end in itself, but that improves performance in similar future situations. This is seen in a wide variety of vertebrates besides humans, but is mostly limited to mammals and birds. Cats are known to play with a ball of string when young, which gives them experience with catching prey. Besides inanimate objects, animals may play with other members of their own species or other animals, such as orcas playing with seals they have caught. Play involves a significant cost to animals, such as increased vulnerability to predators and the risk of injury and possibly infection. It also consumes energy, so there must be significant benefits associated with play for it to have evolved. Play is generally seen in younger animals, suggesting a link with learning. However, it may also have other benefits not associated directly with learning, for example improving physical fitness.

Play, as it pertains to humans as a form of learning is central to a child's

learning and development. Through play, children learn social skills such as sharing and collaboration. Children develop emotional skills such as learning to deal with the emotion of anger, through play activities. As a form of learning, play also facilitates the development of thinking and language skills in children.[16]

There are five types of play:

1. sensorimotor play aka functional play, characterized by repetition of activity
2. role play occurs starting at the age of 3
3. rule-based play where authoritative prescribed codes of conduct are primary
4. construction play involves experimentation and building
5. movement play aka physical play[16]

These five types of play are often intersecting. All types of play generate thinking and problem-solving skills in children. Children learn to think creatively when they learn through play.[17] Specific activities involved in each type of play change over time as humans progress through the lifespan. Play as a form of learning, can occur solitarily, or involve interacting with others.

TOC Previous Next

Enculturation

Main article: Enculturation

Enculturation is the process by which people learn values and behaviors that are appropriate or necessary in their surrounding culture.[18] Parents, other adults, and peers shape the individual's understanding of these values.[18] If successful, enculturation results in competence in the language, values and rituals of the culture.[18] This is different from acculturation, where a person adopts the values and societal rules of a culture different from their native one.

Multiple examples of enculturation can be found cross-culturally.

Collaborative practices in the Mazahua people have shown that participation in everyday interaction and later learning activities contributed to enculturation rooted in nonverbal social experience.[19] As the children participated in everyday activities, they learned the cultural significance of these interactions. The collaborative and helpful behaviors exhibited by Mexican and Mexican-heritage children is a cultural practice known as being "acomedido".[20] Chillihuani girls in Peru described themselves as weaving constantly, following behavior shown by the other adults.[21]

TOC Previous Next

Episodic learning

Episodic learning is a change in behavior that occurs as a result of an event.[22] For example, a fear of dogs that follows being bitten by a dog is episodic learning. Episodic learning is so named because events are recorded into episodic memory, which is one of the three forms of explicit learning and retrieval, along with perceptual memory and semantic memory.[23]

TOC Previous Next

Multimedia learning

Main article: Multimedia learning

Multimedia learning is where a person uses both auditory and visual stimuli to learn information (Mayer 2001). This type of learning relies on dual-coding theory (Paivio 1971).

TOC Previous Next

E-learning and augmented learning

Main article: Electronic learning

Electronic learning or e-learning is computer-enhanced learning. A specific and always more diffused e-learning is mobile learning (m-

learning), which uses different mobile telecommunication equipment, such as cellular phones.

When a learner interacts with the e-learning environment, it's called augmented learning. By adapting to the needs of individuals, the context-driven instruction can be dynamically tailored to the learner's natural environment. Augmented digital content may include text, images, video, audio (music and voice). By personalizing instruction, augmented learning has been shown to improve learning performance for a lifetime.[24] See also minimally invasive education.

Moore (1989)[25] purported that three core types of interaction are necessary for quality, effective online learning:

- learner–learner (i.e. communication between and among peers with or without the teacher present),
- learner–instructor (i.e. student teacher communication), and
- learner–content (i.e. intellectually interacting with content that results in changes in learners' understanding, perceptions, and cognitive structures).

In his theory of transactional distance, Moore (1993)[26] contented that structure and interaction or dialogue bridge the gap in understanding and communication that is created by geographical distances (known as transactional distance).

Rote learning

Main article: Rote learning

Rote learning is memorizing information so that it can be recalled by the learner exactly the way it was read or heard. The major technique used for rote learning is *learning by repetition*, based on the idea that a learner can recall the material exactly (but not its meaning) if the information is repeatedly processed. Rote learning is used in diverse areas, from mathematics to music to religion. Although it has been criticized by some

educators, rote learning is a necessary precursor to meaningful learning.

TOC Previous Next

Meaningful learning

See also: Deeper Learning

Meaningful learning is the concept that learned knowledge (e.g., a fact) is fully understood to the extent that it relates to other knowledge. To this end, meaningful learning contrasts with rote learning in which information is acquired without regard to understanding. Meaningful learning, on the other hand, implies there is a comprehensive knowledge of the context of the facts learned.[27]

TOC Previous Next

Informal learning

Main article: Informal learning

Informal learning occurs through the experience of day-to-day situations (for example, one would learn to look ahead while walking because of the danger inherent in not paying attention to where one is going). It is learning from life, during a meal at table with parents, play, exploring, etc.

TOC Previous Next

Formal learning

Main article: Education

Formal learning is learning that takes place within a teacher-student relationship, such as in a school system. The term formal learning has nothing to do with the formality of the learning, but rather the way it is directed and organized. In formal learning, the learning or training departments set out the goals and objectives of the learning.[28]

Nonformal learning

Main article: Nonformal learning

Nonformal learning is organized learning outside the formal learning system. For example, learning by coming together with people with similar interests and exchanging viewpoints, in clubs or in (international) youth organizations, workshops.

TOC Previous Next

Nonformal learning and combined approaches

The educational system may use a combination of formal, informal, and nonformal learning methods. The UN and EU recognize these different forms of learning (cf. links below). In some schools, students can get points that count in the formal-learning systems if they get work done in informal-learning circuits. They may be given time to assist international youth workshops and training courses, on the condition they prepare, contribute, share and can prove this offered valuable new insight, helped to acquire new skills, a place to get experience in organizing, teaching, etc.

To learn a skill, such as solving a Rubik's Cube quickly, several factors come into play at once:

- Reading directions helps a player learn the patterns that solve the Rubik's Cube.
- Practicing the moves repeatedly helps build "muscle memory" and speed.
- Thinking critically about moves helps find shortcuts, which speeds future attempts.
- Observing the Rubik's Cube's six colors help anchor solutions in the mind.
- Revisiting the cube occasionally helps retain the skill.

Tangential learning

Tangential learning is the process by which people self-educate if a topic is exposed to them in a context that they already enjoy. For example, after playing a music-based video game, some people may be motivated to learn how to play a real instrument, or after watching a TV show that references Faust and Lovecraft, some people may be inspired to read the original work.[29] Self-education can be improved with systematization. According to experts in natural learning, self-oriented learning training has proven an effective tool for assisting independent learners with the natural phases of learning.[30]

Extra Credits writer and game designer James Portnow was the first to suggest games as a potential venue for "tangential learning".[31] Mozelius *et al.*[32] points out that intrinsic integration of learning content seems to be a crucial design factor, and that games that include modules for further self-studies tend to present good results. The built-in encyclopedias in the *Civilization* games are presented as an example - by using these modules gamers can dig deeper for knowledge about historical events in the gameplay. The importance of rules that regulate learning modules and game experience is discussed by Moreno, C. [33], in a case study about the mobile game *Kiwaka*. In this game, developed by Landka in collaboration with ESA and ESO,[34][35] game progress is rewarded with educational content, as opposed to traditional education games where learning activities are rewarded with gameplay.

TOC Previous Next

Dialogic learning

Main article: Dialogic learning

Dialogic learning is a type of learning based on dialogue.

TOC Previous Next

Incidental learning

In *incidental teaching* learning is not planned by the instructor or the student, it occurs as a byproduct of another activity — an experience, observation, self-reflection, interaction, unique event, or common routine task. This learning happens in addition to or apart from the instructor's plans and the student's expectations. An example of incidental teaching is when the instructor places a train set on top of a cabinet. If the child points or walks towards the cabinet, the instructor prompts the student to say “train.” Once the student says “train,” he gets access to the train set.

Here are some steps most commonly used in incidental teaching:[36]

- An instructor will arrange the learning environment so that necessary materials are within the student’s sight, but not within his reach, thus impacting his motivation to seek out those materials.
- An instructor waits for the student to initiate engagement.
- An instructor prompts the student to respond if needed.
- An instructor allows access to an item/activity contingent on a correct response from the student.
- The instructor fades out the prompting process over a period of time and subsequent trials.

Incidental learning is an occurrence that is not generally accounted for using the traditional methods of instructional objectives and outcomes assessment. This type of learning occurs in part as a product of social interaction and active involvement in both online and onsite courses. Research implies that some un-assessed aspects of onsite and online learning challenge the equivalency of education between the two modalities. Both onsite and online learning have distinct advantages with traditional on-campus students experiencing higher degrees of incidental learning in three times as many areas as online students. Additional research is called for to investigate the implications of these findings both conceptually and pedagogically.[37]

Domains

Benjamin Bloom has suggested three domains of learning:

- Cognitive: To recall, calculate, discuss, analyze, problem solve, etc.
- Psychomotor: To dance, swim, ski, dive, drive a car, ride a bike, etc.
- Affective: To like something or someone, love, appreciate, fear, hate, worship, etc.

These domains are not mutually exclusive. For example, in learning to play chess, the person must learn the rules (cognitive domain)—but must also learn how to set up the chess pieces and how to properly hold and move a chess piece (psychomotor). Furthermore, later in the game the person may even learn to love the game itself, value its applications in life, and appreciate its history (affective domain).[38]

TOC | Previous | Next

Transfer

Transfer of learning is the application of skill, knowledge or understanding to resolve a novel problem or situation that happens when certain conditions are fulfilled. Research indicates that learning transfer is infrequent; most common when "... cued, primed, and guided..."[39] and has sought to clarify what it is, and how it might be promoted through instruction.

Over the history of its discourse, various hypotheses and definitions have been advanced. First, it is speculated that different types of transfer exist, including: near transfer, the application of skill to solve a novel problem in a similar context; and far transfer, the application of skill to solve novel problem presented in a different context.[40] Furthermore, Perkins and Salomon (1992) suggest that positive transfer in cases when learning supports novel problem solving, and negative transfer occurs when prior learning inhibits performance on highly correlated tasks, such as second or third-language learning.[41] Concepts of positive and negative transfer have a long history; researchers in the early 20th century described the possibility that "...habits or mental acts developed by a particular kind of training may inhibit rather than facilitate other mental activities".[42] Finally, Schwarz, Bransford and Sears (2005) have proposed that transferring knowledge into a situation may differ from transferring knowledge out to a situation as a means to reconcile findings that transfer may both be frequent and challenging to promote.[43]

A significant and long research history has also attempted to explicate the conditions under which transfer of learning might occur. Early research by Ruger, for example, found that the "level of attention", "attitudes", "method of attack" (or method for tackling a problem), a "search for new points of view", "a careful testing of hypothesis" and "generalization" were all valuable approaches for promoting transfer.[44] To encourage transfer through teaching, Perkins and Salomon recommend aligning ("hugging") instruction with practice and assessment, and "bridging", or encouraging learners to reflect on past experiences or make connections between prior knowledge and current content.[41]

Factors affecting learning

External factors

1. *Heredity*: A classroom instructor can neither change nor increase heredity, but the student can use and develop it. Some learners are rich in hereditary endowment while others are poor. Each student is unique and has different abilities. The native intelligence is different in individuals. Heredity governs or conditions our ability to learn and the rate of learning. The intelligent learners can establish and see relationship very easily and more quickly.
2. *Status of students*: Physical and home conditions also matter: Certain problems like malnutrition i.e.; inadequate supply of nutrients to the body, fatigue i.e.; tiredness, bodily weakness, and bad health are great obstructers in learning. These are some of the physical conditions by which a student can get affected. Home is a place where a family lives. If the home conditions are not proper, the student is affected seriously. Some of the home conditions are bad ventilation, unhygienic living, bad light, etc. These affect the student and his or her rate of learning.[45][46]
3. *Physical environment*: The design, quality, and setting of a learning space, such as a school or classroom, can each be critical to the success of a learning environment. Size, configuration, comfort—fresh air, temperature, light, acoustics, furniture—can all affect a student's learning. The tools used by both instructors and students directly affect how information is conveyed, from display and writing surfaces (blackboards, markerboards, tack surfaces) to digital technologies. For example, if a room is too crowded, stress levels rise, student attention is reduced, and furniture arrangement is restricted. If furniture is incorrectly arranged, sight lines to the instructor or instructional material is limited and the ability to suit the learning or lesson style is restricted. Aesthetics can also play a role, for if student morale suffers, so does motivation to attend school.[47][48]

TOC | Previous | Next

Internal factors

There are several internal factors that affect learning.[49][50] They are

1. *Goals or purposes*: Each and everyone has a goal. A goal should be set to each pupil according to the standard expected to him. A goal is an aim or desired result. There are 2 types of goals called immediate and distant goals. A goal that occurs or is done at once is called an *immediate goal*, and *distant goals* are those that take time to achieve. Immediate goals should be set before

the young learner and distant goals for older learners. Goals should be specific and clear, so that learners understand.

2. *Motivational behavior*: Motivation means to provide with a motive. Motivation learners should be motivated so that they stimulate themselves with interest. This behavior arouses and regulates the student's internal energies.
3. *Interest*: This is a quality that arouses a feeling. It encourages a student to move over tasks further. During teaching, the instructor must raise interests among students for the best learning. Interest is an apparent (clearly seen or understood) behaviour.
4. *Attention*: Attention means consideration. It is concentration or focusing of consciousness upon one object or an idea. If effective learning should take place attention is essential. Instructors must secure the attention of the student.
5. *Drill or practice*: This method includes repiting the tasks "n" number of times like needs, phrases, principles, etc. This makes learning more effective.
6. *Fatigue*: Generally there are three types of fatigue, i.e., muscular, sensory, and mental. Muscular and sensory fatigues are bodily fatigue. Mental fatigue is in the central nervous system. The remedy is to change teaching methods, e.g., use audio-visual aids, etc.
7. *Aptitude*: Aptitude is natural ability. It is a condition in which an individuals ability to acquire certain skills, knowledge through training.
8. *Attitude*: It is a way of thinking. The attitude of the student must be tested to find out how much inclination he or she has for learning a subject or topic.
9. *Emotional conditions*: Emotions are physiological states of being. Students who answer a question properly or give good results should be praised. This encouragement increases their ability and helps them produce better results. Certain attitudes, such as always finding fault in a student's answer or provoking or embarrassing the student in front of a class are counterproductive.
10. *Speed, Accuracy and retention*: Speed is the rapidity of movement. Retention is the act of retaining. These 3 elements depend upon aptitude, attitude, interest, attention and motivation of the students.
11. *Learning activities*: Learning depends upon the activities and experiences provided by the teacher, his concept of discipline, methods of teaching and above all his overall personality.
12. *Testing*: Various tests measure individual learner differences at the heart of effective learning. Testing helps eliminate subjective elements of measuring pupil differences and performances.
13. *Guidance*: Everyone needs guidance in some part or some time in life. Some need it constantly and some very rarely depending on the students conditions. Small learners need more guidance. Guidance is an advice to solve a problem. Guidance involves the art of helping boys and girls

in various aspects of academics, improving vocational aspects like choosing careers and recreational aspects like choosing hobbies. Guidance covers the whole gamut of learners problems- learning as well as non- learning.

TOC ← Previous Next →

In animal evolution

Animals gain knowledge in two ways. First is learning—in which an animal gathers information about its environment and uses this information. For example, if an animal eats something that hurts its stomach, it learns not to eat that again. The second is innate knowledge that is genetically inherited. An example of this is when a horse is born and can immediately walk. The horse has not learned this behavior; it simply knows how to do it.[51] In some scenarios, innate knowledge is more beneficial than learned knowledge. However, in other scenarios the opposite is true—animals must learn certain behaviors when it is disadvantageous to have a specific innate behavior. In these situations, learning evolves in the species.

TOC | Previous | Next

Costs and benefits of learned and innate knowledge

In a changing environment, an animal must constantly gain new information to survive. However, in a stable environment, this same individual needs to gather the information it needs once, and then rely on it for the rest of its life. Therefore, different scenarios better suit either learning or innate knowledge. Essentially, the cost of obtaining certain knowledge versus the benefit of already having it determines whether an animal evolved to learn in a given situation, or whether it innately knew the information. If the cost of gaining the knowledge outweighes the benefit of having it, then the animal does not evolve to learn in this scenario—but instead, non-learning evolves. However, if the benefit of having certain information outweighs the cost of obtaining it, then the animal is far more likely to evolve to have to learn this information.[51]

Non-learning is more likely to evolve in two scenarios. If an environment is static and change does not or rarely occurs, then learning is simply unnecessary. Because there is no need for learning in this scenario—and because learning could prove disadvantageous due to the time it took to learn the information—non-learning evolves. However, if an environment is in a constant state of change, then learning is disadvantageous. Anything learned is immediately irrelevant because of the changing environment.[51] The learned information no longer applies. Essentially, the animal would be just as successful if it took a guess as if it learned. In this situation, non-learning evolves. In fact, a study of *Drosophila melanogaster* showed that learning can actually lead to a decrease in productivity, possibly because egg-laying behaviors and decisions were impaired by interference from the memories gained from the new learned materials or because of the cost of energy in learning.[52]

However, in environments where change occurs within an animal's lifetime but is not constant, learning is more likely to evolve. Learning is beneficial in these scenarios because an animal can adapt to the

new situation, but can still apply the knowledge that it learns for a somewhat extended period of time. Therefore, learning increases the chances of success as opposed to guessing.[51] An example of this is seen in aquatic environments with landscapes subject to change. In these environments, learning is favored because the fish are predisposed to learn the specific spatial cues where they live.[53]

Machine learning

Main article: Machine learning

Machine learning, a branch of artificial intelligence, concerns the construction and study of systems that can learn from data. For example, a machine learning system could be trained on email messages to learn to distinguish between spam and non-spam messages.

TOC | Previous | Next

See also

- 21st century skills
- Epistemology
- Implicit learning
- Instructional theory
- Learning sciences
- Lifelong learning
- Living educational theory
- Media psychology
- Subgoal labeling

TOC | Previous | Next

Information theory

- Algorithmic information theory
- Algorithmic probability
- Bayesian inference
- Inductive logic programming
- Inductive probability
- Information theory
- Minimum description length
- Minimum message length
- Occam's razor
- Solomonoff's theory of inductive inference
- Universal artificial intelligence

TOC | Previous | Next

Types of education

- Andragogy
- Heutagogy
- Pedagogy

TOC | Previous | Next

Notes

1. ^ Richard Gross, Psychology: The Science of Mind and Behaviour 6E, Hachette UK, ISBN 9781444164367.
2. ^ Karban, R. (2015). Plant Learning and Memory. In: *Plant Sensing and Communication*. Chicago and London: The University of Chicago Press, pp. 31-44, [1].
3. ^ Daniel L. Schacter; Daniel T. Gilbert; Daniel M. Wegner (2011) [2009]. *Psychology, 2nd edition*. Worth Publishers. p. 264. ISBN 978-1-4292-3719-2.
4. ^ Jungle Gyms: The Evolution of Animal Play Archived 2007-10-11 at the Wayback Machine.
5. ^ "What behavior can we expect of octopuses? - The Cephalopod Page". *www.thecephalopodpage.org*. Archived from the original on 5 October 2017. Retrieved 4 May 2018.
6. ^ Learned helplessness at *Encyclopædia Britannica*
7. ^ Sandman, Wadhwa; Hetrick, Porto; Peeke (1997). "Human fetal heart rate dishabituation between thirty and thirty-two weeks gestation". *Child Development*. **68**: 1031–1040. doi:10.1111/j.1467-8624.1997.tb01982.x.
8. ^ "Archived copy" (PDF). Archived (PDF) from the original on 2014-01-03. Retrieved 2013-08-09.
9. ^ Gagliano, M.; et al. (2014). "Experience teaches plants to learn faster and forget slower in environments where it matters". *Oecologia*. **175**: 1. doi:10.1007/s00442-013-2873-7.
10. ^ Wood, D.C. (1988). "Habituation in *Stentor* produced by mechanoreceptor channel modification". *Journal of Neuroscience*. **2254**: 8.
11. ^ Igor Kokcharov, Ph.D, PMP (22 May 2015). "Hierarchy of Skills". *slideshare.net*. Archived from the original on 17 December 2016. Retrieved 4 May 2018.
12. ^ [(Bransford, 2000, pg.15-20)]
13. ^ J. Scott Armstrong (2012). "Natural Learning in Higher Education". *Encyclopedia of the Sciences of Learning*. Archived from the original on 2014-09-16.
14. ^ Bitterman; et al. (1983). "Classical Conditioning of Proboscis Extension in Honeybees (*Apis mellifera*)". *J. Comp. Psychol*. **97**: 107–119. doi:10.1037/0735-7036.97.2.107.
15. ^ Gagliano, Monica; Vyazovskiy, Vladyslav V.; Borbély, Alexander A.; Grimonprez, Mavra; Depczynski, Martial (2016-12-02). "Learning by Association in Plants". *Scientific Reports*. **6** (1). doi:10.1038/srep38427. ISSN 2045-2322. PMC 5133544 . PMID 27910933. Archived from the original on 2017-06-23.
16. ^ ***a b*** Lillemyr, O.F. (2009). Taking play seriously. Children and play in early childhood

education: an exciting challenge. Charlotte, NC: Information Age Publishing.

17. ^ Whitebread, D.; Coltman, P.; Jameson, H.; Lander, R. (2009). "Play, cognition and self-regulation: What exactly are children learning when they learn through play?". *Educational & Child Psychology*. **26** (2): 40–52.
18. ^ *a b c* Grusec, Joan E.; Hastings, Paul D. "Handbook of Socialization: Theory and Research", 2007, Guilford Press; ISBN 1-59385-332-7, ISBN 978-1-59385-332-7; at page 547.
19. ^ Paradise, Ruth (1994). "Interactional Style and Nonverbal Meaning: Mazahua Children Learning How to Be Separate-But-Together". *Anthropology & Education Quarterly*. **25**: 156–172. doi:10.1525/aeq.1994.25.2.05x0907w.
20. ^ Lopez, Angelica; Najafi, Behnosh; Rogoff, Barbara; Mejia-Arauz, Rebeca (2012). "Collaboration and helping as cultural practices". *The Oxford Handbook of Culture and Psychology*.
21. ^ Bolin, Inge (2006). *Growing Up in a Culture of Respect: Childrearing in highland Peru* (2 ed.). Austin: University of Texas. pp. 90–99. ISBN 978-0-292-71298-0.
22. ^ Terry, W. S. (2006). Learning and Memory: Basic principles, processes, and procedures. Boston: Pearson Education, Inc.
23. ^ Baars, B. J. & Gage, N. M. (2007). Cognition, Brain, and Consciousness: Introduction to cognitive neuroscience. London: Elsevier Ltd.
24. ^ Augmented Learning, Augmented Learning: Context-Aware Mobile Augmented Reality Architecture for Learning
25. ^ Moore, M (1989). "Three types of interaction". *American Journal of Distance Education*. **3** (2): 1–6. doi:10.1080/08923648909526659.
26. ^ Moore, M. G. (1993). Theory of transactional distance. In D. Keegan (Ed.), Theoretical principles of distance education (pp. 22-38). London and New York: Routledge
27. ^ Hassard, Jack. "Backup of Meaningful Learning Model". Archived from the original on 29 October 2011. Retrieved 30 November 2011.
28. ^ Bell, J., and Dale, M., " Informal Learning in the Workplace" Archived 2013-01-21 at the Wayback Machine., *Department for Education and Employment Research Report No. 134. London, England: Department for Education and Employment*, August 1999
29. ^ Tangential Learning "Archived copy". Archived from the original on 2012-01-04. Retrieved 2012-01-31.
30. ^ J. Scott Armstrong (1979). "The Natural Learning Project". *Journal of Experiential Learning and Simulation*. **1**: 5–12. Archived from the original on 2014-10-19.
31. ^ Robert, Rath, (2015-01-22). "Game Criticism as Tangential Learning Facilitator: The Case of Critical Intel". *Journal of Games Criticism*. **2** (1).

32. ^ Mozelius; et al. "Motivating Factors and Tangential Learning for Knowledge Acquisition in Educational Games" (PDF). *The Electronic Journal of e-Learning*. Volume 15 Issue 4 2017.
33. ^ Moreno, Carlos (2014). "Kiwaka | Kiwaka Story (by LANDKA®)" (PDF). *LifePlay*. **3**.
34. ^ European Southern Observatory. "New App Kiwaka Features ESO Material". *www.eso.org*. Retrieved 2018-06-10.
35. ^ LANDKA (2014). "Kiaka Press Release" (PDF). *http://landka.com/documents/10/Kiwaka-PressRelease.pdf*.
36. ^ "What is incidental teaching?". *North Shore Pediatric Therapy, Illinois*. 2017. Archived from the original on August 29, 2017. Retrieved August 29, 2017.
37. ^ Konetes, George (2011). "The Effects of Distance Education and Student Involvement on Incidental Learning" (PDF). *IUP Doctoral Dissertations*: 115. Archived from the original (PDF) on 2014-07-14. Retrieved 2014-07-12.
38. ^ "Bloom's Taxonomy". *www.businessballs.com*. Retrieved 4 May 2018.
39. ^ Perkins, D.N.; Salomon, G. (Jan–Feb 1989). "Are Cognitive Skills Context-Bound?". *Educational Researcher*. **18** (1): 16–25 [19]. doi:10.3102/0013189x018001016.
40. ^ Committee on Developments in the Science of Learning with additional material from the Committee on Learning Research (2000). *Chapter 3. Learning and Transfer. How People Learn: Brain, Mind, Experience, and School: Expanded Edition*. The National Academies Press. Archived from the original on 2013-04-26.
41. ^ *a b* Perkins, D.N.; Salomon, G. (1992). "Transfer of Learning". *International Encyclopedia of Education*. **2**.
42. ^ Rogers, Agnes L. (1916). "The Bearing of the New Psychology upon the Teaching of Mathematics". *Teacher's College Record*. **17**: 344–352.
43. ^ Schwartz, Daniel L., John D. Bransford, and David Sears (2005). "Efficiency and innovation in transfer: Transfer of learning from a modern multidisciplinary perspective": 1–15.
44. ^ Ruger, Henry Alfred (1910). "The psychology of efficiency: an experimental study of the processes involved in the solution of mechanical puzzles and in the acquisition of skill in their manipulation". *Science Press*. **19** (2).
45. ^ Mangal, S.K. (January 5, 2007). *ESSENTIALS OF EDUCATIONAL PSYCHOLOGY*. PHI Learning Pvt. Ltd. p. 736. ISBN 9788120330559.
46. ^ Aggarwal, J.C (November 1, 2009). *Essentials Of Educational Psychology* (Second ed.). Vikas Publishing House Pvt Ltd. p. 596. ISBN 9788125922926.
47. ^ *New Teachers: Designing Learning Environments*, May 7, 2015 Archived March 28, 2016, at the Wayback Machine.. Retrieved 2016-03-19
48. ^ *A Place for Learning: The Physical Environment of Classrooms*, Mark Phillips, May 20,

2014 Archived March 13, 2016, at the Wayback Machine.. Retrieved 2016-03-19

49. ^ Mangal, SK (January 1, 2002). *ADVANCED EDUCATIONAL PSYCHOLOGY* (Second ed.). PHI Learning Pvt. Ltd. p. 536. ISBN 9788120320383.
50. ^ Bhatia, H.R (January 1, 1973). *Elements Of Educational Psychology*. Orient Blackswan. p. 558. ISBN 9788125000297.
51. ^ ***a b c d*** DunlapLehtila_umn_0130E_10349.pdf. at <"Archived copy" (PDF). Archived from the original (PDF) on 2013-11-13. Retrieved 2013-12-15.>
52. ^ "An operating cost of learning in Drosophila melanogaster". *Animal Behaviour*. **68**: 589–598. doi:10.1016/j.anbehav.2003.12.005.
53. ^ Odling-Smee, L.; Braithwaite, V. A. (2003). "The role of learning in fish orientation". *Fish and Fisheries*. **4**: 235–246. doi:10.1046/j.1467-2979.2003.00127.x.

References

- Mayer, R.E. (2001). *Multimedia learning*. New York: Cambridge University Press. ISBN 0-521-78749-1.
- Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart, and Winston. ISBN 978-0-03-085173-5.

TOC Previous

External links

- *How People Learn: Brain, Mind, Experience, and School* (expanded edition) published by the National Academies Press
- *Applying Science of Learning in Education: Infusing Psychological Science into the Curriculum* published by the American Psychological Association

Categories: Learning | Cognitive science | Educational psychology | Developmental psychology | Intelligence | Neuropsychological assessment | Systems science

Back to main TOC

Contents

Prosodic Unit

Jump to navigation Jump to search

In linguistics, a **prosodic unit**, often called an **intonation unit** or **intonational phrase**, is a segment of speech that occurs with a single prosodic contour (pitch and rhythm contour). The abbreviation **IU** is used and therefore the full form is often found as *intonation unit,* despite the fact that technically it is a unit of prosody rather than intonation, which is only one element of prosody.

Prosodic units occur at a hierarchy of levels, from the metrical foot and phonological word to a complete utterance. However, the term is generally restricted to intermediate levels which do not have a dedicated terminology. Prosodic units do not generally correspond to syntactic units, such as phrases and clauses; it is thought that they reflect different aspects of how the brain processes speech, with prosodic units being generated through on-line interaction and processing, and with morphosyntactic units being more automated.

TOP

TOC Next

Defining characteristics

Prosodic units are characterized by several phonetic cues, such as a coherent pitch contour. Breathing, both inhalation and exhalation, only occurs at the boundaries (pausa) between higher units. Several short contours may carry an additional overall gradual decline in pitch and slowing of tempo; this larger unit is termed a *declination unit* (DU). At the boundaries (pauses) between declination units, the pitch and tempo reset; for this reason the final one of the shorter internal contours is said to have *final* prosody, whereas the others are said to have *continuing* prosody.

These two levels of the hierarchy may be schematized as follows:

TOC Previous Next

Transcription

In English orthography, a *continuing* prosodic boundary may be marked with a comma (assuming the writer is using commas to represent prosody rather than grammatical structure), while *final* prosodic boundaries may be marked with a full stop (period).

The International Phonetic Alphabet has symbols (single and double pipes) for "minor" and "major" prosodic breaks. Since there are more than two levels of prosodic units, the use of these symbols depends on the structure of the language and which information the transcriber is attempting to capture. Very often, each prosodic unit will be placed in a separate line of the transcription. Using the single and double pipes to mark continuing and final prosodic boundaries, we might have American English,

> *Jack,*
> *preparing the way,*
> *went on.*
> [ˈdʒæk | pɹəˌpɛəɹɪŋ ðə ˈweɪ | wɛnt ˈɒn ‖]

or French,

> *Jacques,*
> *préparant le sol,*
> *tomba.*
> [ˈʒak | pʁepaʁɑ̃lɵ ˈsɔl | tɔ̃ba ‖]

Note that the last syllable with a full vowel in a French prosodic unit is stressed, and that the last stressed syllable in an English prosodic unit has primary stress. This shows that stress is not phonemic in French, and that the difference between primary and secondary stress is not phonemic in English; they are both elements of prosody rather than inherent in the words.

The pipe symbols – the vertical bars | and ‖ – used above are phonetic,

and so will often disagree with English punctuation, which only partially correlates with prosody.

However, the pipes may also be used for metrical breaks – a single pipe being used to mark metrical feet, and a double pipe to mark both continuing and final prosody, as their alternate IPA descriptions "foot group" and "intonation group" suggest. In such usage, each foot group would include one and only one heavy syllable. In English, this would mean one and only one stressed syllable:

> *Jack,*
> *preparing the way,*
> *went on.*
> [ˈdʒæk ‖ pɹəˌpɛəɹɪŋ | ðə ˈweɪ ‖ wɛnt ˈɒn ‖]

In many tone languages with downdrift, such as Hausa, the single pipe ⟨|⟩ may be used to represent a minor prosodic break that does not interrupt the overall decline in pitch of the utterance, while ⟨‖⟩ marks either continuing or final prosody that creates a pitch reset. In such cases, some linguists use only the single pipe, with continuing and final prosody marked by a comma and period, respectively.

In transcriptions of non-tonal languages, the three symbols pipe, comma, and period may also be used, with the pipe representing a break more minor than the comma, the so-called *list prosody* often used to separate items when reading lists, spelling words, or giving out telephone numbers.

TOC | Previous | Next

Cognitive implications

While each prosodic unit may carry a large information load in rehearsed speech, in extemporaneous conversation the amount of information is much more limited. There is seldom more than a single lexical noun in any one IU, and it is uncommon to have both a lexical noun and a lexical verb in the same IU. Indeed, many IUs are semantically empty, taken up by filler words such as *um*, *well*, or *y'know*. Chafe (1994) believes that this reflects the constraints of information processing by the brain during speech production, with chunks of speech (IUs) corresponding to chunks of cognitive output. It is also a possibility that the distribution of information across IUs is designed to maximize language comprehension by the other party.

See also

- Phonological hierarchy
- Tone terracing
- Upstep

TOC | Previous | Next

Notes

TOC Previous

References

- Chafe, Wallace. 1994. *Discourse, Consciousness, and Time: The flow and displacement of conscious experience in speaking and writing.* University of Chicago Press.
- Dubois, John W., Susanna Cumming, Stephan Schuetze-Coburn, Danae Paolino eds. 1992. *Discourse Transcription.* Volume 4 of the *Santa Barbara Papers in Linguistics.*

Categories:

- Phonology
- Phonetics
- Cognitive science
- Prosody (linguistics)

This page was last edited on 15 February 2018, at 21:08.

Back to main TOC

Contents

Crosslinguistic Influence

Jump to navigation Jump to search

Crosslinguistic influence (**CLI**) refers to the different ways in which one language can affect another within an individual speaker. It typically involves two languages that can affect one another in a bilingual speaker.[1] An example of CLI is the influence of Korean on a Korean native speaker who is learning Japanese or French. Less typically, it could also refer to an interaction between different dialects in the mind of a monolingual speaker. CLI can be observed across subsystems of languages including pragmatics, semantics, syntax, morphology, phonology, phonetics, and orthography.[2] Discussed further in this article are particular subcategories of CLI—transfer, attrition, the complementarity principle, and additional theories.

TOP

TOC Next

History

The question of how languages influence one another within a bilingual individual can be addressed both with respect to mature bilinguals and with respect to bilingual language acquisition. With respect to bilingual language acquisition in children, there are several hypotheses that examine the internal representation of bilinguals' languages. Volterra and Taeschner proposed the *Single System Hypothesis,*[3] which states that children start out with one single system that develops into two systems. This hypothesis proposed that bilingual children go through three stages of acquisition.

- In Stage I there is a single lexicon that contains words from both languages, and there is a single syntactic system. Children in this stage will never have a translation equivalent for a word in the other language. Translation equivalents are two corresponding words in two separate languages with the same meaning. Also, it is common for the child to use two different languages in a single utterance. The syntactic rules are hard to define because of the lack of two-word and three-word utterances by the bilingual child.
- In Stage II there are two lexicons, but there is one syntactic system. In addition, there is evidence for language separation because at this stage children become less likely to mix their languages. Across both languages, the same syntactic rules are applied. For example, Japanese has subject-object-verb word order (SOV), and English has subject-verb-object word order (SVO). An English-Japanese bilingual might apply only one of these word orders to all utterances, regardless of what language the utterance is in.
- In Stage III there are two lexicons and two syntactic systems, with adult-like separation of the languages. When a child reaches this stage they are considered fully "bilingual."[3]

In response to the *Single System Hypothesis*, a different hypothesis developed regarding the idea of two separate language systems from the very beginning. It was based on evidence of monolinguals and bilinguals reaching the same milestones at approximately the same stage of development.[4][5] For example, bilingual and monolingual children go

through identical patterns of grammar development. This hypothesis, called the *Separate Development Hypothesis*, held the notion that the bilinguals acquiring two languages would internalize and acquire the two languages separately. Evidence for this hypothesis comes from lack of transfer and lack of acceleration.[6] Transfer is a grammatical property of one language used in another language. Acceleration is the acquisition of a feature in language A facilitating the acquisition of a feature in language B.[7] In a study of Dutch-English bilingual children, there were no instances of transfer across elements of morphology and syntactic development, indicating that the two languages developed separately from each other.[8] In addition, in a study of French-English bilingual children, there were no instances of acceleration because finiteness appeared much earlier in French than it did in English, suggesting that there was no facilitation of the acquisition of finiteness in English by acquisition in French.[6] Under this hypothesis, bilingual acquisition would be equivalent to monolingual children acquiring the particular languages.[8]

In response to both the previous hypotheses mentioned, the *Interdependent Development Hypothesis* emerged with the idea that there is some sort of interaction between the two language systems in acquisition. It proposed that there is no single language system, but the language systems are not completely separate either. This hypothesis is also known as the *Crosslinguistic Hypothesis*, developed by Hulk and Müller. The *Crosslinguistic Hypothesis* states that influence will occur in bilingual acquisition in areas of particular difficulty, even for monolingual native language acquisition. It re-examined the extent of the differentiation of the language systems due to the interaction in difficult areas of bilingual acquisition.[9][10] Evidence for this hypothesis comes from delay, acceleration, and transfer in particular areas of bilingual language acquisition. Delay is the acquisition of a property of language A later than normally expected because of the acquisition of language B.[6] CLI is seen when the child has a dominant language, such as Cantonese influencing English when Cantonese is the dominant language,[11] and it will only occur in certain domains. Below are the two proposals represented in the *Crosslinguistic Hypothesis* where CLI may occur.[12]

- It may occur where there is an interface.[9] An interface, for example, could be between syntax and pragmatics of dislocations. Dislocations are a grammatical option in French under certain pragmatic conditions (e.g. *Je l'aime, ça* 'I like it, that'), which have been studied in French-English bilinguals positioning of the word *that*. French-English bilinguals make use of this device when they move *that* to a dislocated position of the periphery of the sentence in English. The placement of *that* was dislocated in English sentences because of the influence from French on English syntax. For example, French-English bilingual children may produce *Is a big one this?* instead of meaning to say *Is this a big one?* The children produced significantly more of these dislocations in English than monolingual English children.[13]
- It may occur where is an overlap between two languages with language A allowing only one option and language B allowing two options. One option of language B overlaps with an option in language A.[9] For example, French allows adjectives before and after a noun, but English only allows adjectives before the noun. There is an overlap in the correct placement of adjectives between these two languages, and there will be transfer, especially with postnominal adjectives in French. For example, French-English bilinguals might produce *un blanc chien* "a white dog" instead of *un chien blanc* "a dog white."[14]

Since the development of the *Crosslinguistic Hypothesis*, much research has contributed to the understanding of CLI in areas of structural overlap, directionality, dominance, interfaces, the role of input, and the role of processing and production.[1]

TOC | Previous | Next

Transfer

In linguistics, language transfer is defined by behaviorist psychologists as the subconscious use of behaviors from one language in another. In the Applied Linguistics field, it is also known as exhibiting knowledge of a native or dominant language (L1) in one that is being learned (L2).[15] Transfer occurs in various language-related settings, such as acquiring a new language and when two languages or two dialects come into contact. Transfer may depend on how similar the two languages are and the intensity of the conversational setting. Transfer is more likely to happen if the two languages are in the same language family.[15] It also occurs more at the beginning stages of L2 acquisition, when the grammar and lexicon are less developed. As the speaker's L2 proficiency increases, they will experience less transfer.[16]

Jacquelyn Schachter (1992) argues that transfer is not a process at all, but that it is improperly named. She described transfer as "an unnecessary carryover from the heyday of behaviorism." In her view, transfer is more of a constraint on the L2 learners' judgments about the constructions of the acquired L2 language. Schachter stated, "It is both a facilitating and a limiting condition on the hypothesis testing process, but it is not in and of itself a process."[17]

Language transfer can be positive or negative. Transfer between similar languages often yields correct production in the new language because the systems of both languages are similar. This correct production would be considered positive transfer.[15] An example involves a Spanish speaker (L1) who is acquiring Catalan (L2). Because the languages are so similar, the speaker could rely on their knowledge of Spanish when learning certain Catalan grammatical features and pronunciation. However, the two languages are distinct enough that the speaker’s knowledge of Spanish could potentially interfere with learning Catalan properly.

Negative transfer (Interference)[18] occurs when there are little to no similarities between the L1 and L2. It is when errors and avoidance are more likely to occur in the L2. The types of errors that result from this type

of transfer are underproduction, overproduction, miscomprehension, and production errors, such as substitution, calques, under/overdifferentiation and hypercorrection.[19]

TOC Previous Next

Underproduction (Avoidance)

Underproduction as explained by Schachter (1974),[20] is a strategy used by L2 learners to avoid producing errors when using structures, sounds, or words which they are not confident about in the L2. Avoidance is a complex phenomenon and experts do not agree on its causes or exactly what it is.[21][22] For example, Hebrew speakers acquiring English, may understand how the passive voice, 'a cake is made', works, but may prefer active voice, 'I make a cake,' thus avoiding the passive construction. Kellerman (1992) distinguishes three types of avoidance: (1) learners of the L2 make anticipations or know there is a problem with their construction and have a vague idea of the target construction, (2) the target is known by the L1 speaker, but it is too difficult to use in given circumstances; such as conversational topics that the L1 speaker may have a deficiency in or (3), the L1 speaker has the knowledge to correctly produce and use the L2 structure but is unwilling to use it because it goes against the norms of their behavior.[21]

TOC Previous Next

Overproduction

Overproduction refers to an L2 learner producing certain structures within the L2 with a higher frequency than native speakers of that language. In a study by Schachter and Rutherford (1979), they found that Chinese and Japanese speakers who wrote English sentences overproduced certain types of cleft constructions:

- 'It is very unfortunate that...'

and sentences that contained *There are*/*There is* which suggests an influence of the topic marking function in their L1 appearing in their L2

English sentences.

Production errors

Substitution is when the L1 speaker takes a structure or word from their native language and replaces it within the L2.[19] Odlin (1989) shows a sentence from a Swedish learner of English in the following sentence.

- Swedish Structure on English:
  - But sometimes I must go bort.[19]

Here the Swedish word *bort* has replaced its English equivalent *away*.

- Polish learner of English:
  - English *think* pronounced as [*fink*] because of the influence of the Polish accent on English pronunciation.[*citation needed*]

A Calque is a direct "loan translation" where words are translated from the L1 literally into the L2.[23]

- English *skyscraper* literally translates in French as *gratte-ciel* ("scrapes-sky")[23]
- Polish *palec srodkowy* literally translates to a *finger middle* in English.[*citation needed*]
- Scottish Gaelic "a' coimhead air adhart" (literal translation of "looking forwards"), c.f. native expression, "Tha fiughair agam ris" ("I have anticipation of it")[24]

Overdifferentiation occurs when distinctions in the L1 are carried over to the L2.

- An English L1 learner of Polish applies different vowel lengths of English (e.g. /i/ and /i:/) to their Polish due to the use of vowel distinctions in English.[*citation needed*]

Underdifferentiation occurs when speakers are unable to make distinctions

in the L2.

- A Polish learner of English assumes the words *borrow* and *lend* are equivalent in meaning, since both correspond to *posyzyc* in Polish.[*citation needed*]
- Scottish Gaelic learners whose first language was English pronounce the phonemes /l̪ˠ/, /l/, and /ʎ/ identically, since English has only one lateral phoneme.[*citation needed*]

Hypercorrection is a process where the L1 speaker finds forms in the L2 they consider to be important to acquire, but these speakers do not properly understand the restrictions or exceptions to formal rules that are in the L2, which results in errors, such as the example below.[18]

- Polish speakers of English may say: potato pronounced as [pota:to] paralleled tomato [toma:to][18]

TOC Previous Next

Attrition

Also related to the idea of languages interfering with one another is the concept of language attrition. Language attrition, simply put, is language loss. Attrition can occur in an L1 or an L2. According to the *Interference Hypothesis* (also known as the *Crosslinguistic Influence Hypothesis*), language transfer could contribute to language attrition.[25] If a speaker moved to a country where their L2 is the dominant language and the speaker ceased regular use of their L1, the speaker could experience attrition in their L1. However, second language attrition could just as easily occur if the speaker moved back to a place where their L1 was the dominant language, and the speaker did not practice their L2 frequently. Attrition could also occur if a child speaker's L1 is not the dominant language in their society. A child whose L1 is Spanish, but whose socially dominant language is English, could experience attrition of their Spanish simply because they are restricted to using that language in certain domains.[12] Much research has been done on such speakers, who are called heritage language learners. When discussing CLI, attrition is an important concept to keep in mind because it is a direct result of two or more languages coming into contact and the dominance of one over the other resulting in language loss in a speaker.

Complementarity principle

Grosjean (1997) explained the complementarity principle as the function of language use in certain domains of life leading to language dominance within that domain for a given speaker.[26] This dominance in certain domains of life (e.g. school, home, work, etc.) can lead to apparent Crosslingusitic Influence within a domain. One study found that CLI was occurring within the speech of the studied bilinguals, but the intensity of influence was subject to the domains of speech being used.[27] Argyri and Sorace (2007) found, much like many other researchers, that language dominance plays a role in the directionality of CLI.[28] These researchers found that the English dominant bilinguals had influence of English on their Greek (concerning preverbal subjects specifically, but also the language in general), but not from their Greek to their English. On the other hand, the Greek dominant bilinguals did not show evidence of Greek influence on their English.[28]

This supports the notion that bilinguals who do not receive sufficient exposure to both languages acquire a "weaker language" and a "dominant language," and depending on similarities or differences between the languages, effects can be present or absent like that of the Greek-English example above. The effect of CLI can be primarily seen as a unidirectional occurrence, in that the L2 is likely to be affected by the L1, or simply the dominant language is more likely to affect the weaker, than the reverse. This supports the idea of individuals' susceptibility to crosslinguistic influences and the role of dominance. Take for example bilinguals who use different languages for different domains in their life; if a Spanish-English bilingual primarily uses Spanish in the home, but English in school you would expect to see English influences while speaking about school topics in Spanish and similarly you would expect Spanish influences on English when speaking about the home in English because in both instances the language being used is weaker in that domain. This is to say that not only do you see CLI from one language to another, but depending on the domains of use and the degree of proficiency or dominance, CLI can be a significant influence on speech production.

Additional theories

Some researchers believe that CLI may be a result of "contact-modified input," or linguistic input modified or affected by some other source such as another language.[29] This is to say that the environment surrounding the learning of another language can influence what is actually being learned. Take for example the fact that most L2 learners are receiving input or teachings from similarly speaking bilinguals; Hauser-Grüdl, Guerra, Witzmann, Leray, and Müller (2010) believe that the language being taught has already been influenced by the other in the teachers' minds and, therefore, the input the learner is receiving will exhibit influence.[29] These L2 learners will replicate influences because their input of the L2 is not as pure as input from a monolingual; meaning, what appears as CLI in the individual isn't really CLI of their L1 on their L2, but the effects of acquiring input that has already been modified. This theory has led some people to believe that all input for L2 learning will be affected and resemble CLI; however, this is not a well supported theory of CLI or its function in L2 acquisition.

Other researchers believe that CLI is more than production influences, claiming that this linguistic exchange can impact other factors of a learner’s identity. Jarvis and Pavlenko (2008) described such affected areas as experiences, knowledge, cognition, development, attention and language use, to name a few, as being major centers for change because of CLI.[30] These ideas suggest that crosslinguistic influence of syntactic, morphological, or phonological changes may just be the surface of one language’s influence on the other, and CLI is instead a different developmental use of one’s brain.[30]

Future research

CLI has been heavily studied by scholars, but there is still much more research needed because of the multitude of components that make up the phenomenon. Firstly, the typology of particular language pairings needs to be researched to differentiate CLI from the general effects bilingualism and bilingual acquisition.

Also, research is needed in specific areas of overlap between particular language pairings and the domains that influence and discourage CLI.[1] For example, most of the research studies involve European language combinations, and there is a significant lack of information regarding language combinations involving non-European languages, indigenous languages, and other minority languages.

More generally, an area of research to be further developed are the effects of CLI in multilingual acquisition of three or more languages. There is limited research on this occurrence.[31]

References

1. ^ *a* *b* *c* *Serratrice, Ludovica (2013). "Cross-linguistic influence in bilingual development Determinants and mechanisms". Linguistic approaches to bilingualism.* ***3****: 3–25.*
2. ^ Odlin, Terence (2003). "Cross-Linguistic Influence". *The Handbook of Second Language Acquisition*. Oxford: Blackwell. p. 437.
3. ^ *a* *b* *Volterra, Virginia; Taeschner, Traute (1978). "The acquisition and development of language by bilingual children" (PDF). Journal of Child Language.* ***5****.*
4. ^ Cantone, K. (1999). Das Genus im Italienischen und Deutschen: Empirische Untersuchung zum bilingualen Erstspracherwerb. Unpublished doctoral dissertation, University of Hamburg.
5. ^ Müller, Natascha (1990). "Developing two gender assignment systems simultaneously". *J. Meisel*. Two first languages. Early grammatical development in bilingual children: 194-243.
6. ^ *a* *b* *c* Paradis, Johanne; Genessee, Fred (1996). "Syntactic acquisition in bilingual children: Autonomous or interdependent?". *Studies in Second Language Acquisition*. **18**: 1-25.
7. ^ Mishina-Mori, Satomi (2005). "Autonomous and interdependent development of two language systems in Japanese/English simultaneous bilinguals: Evidence from question formation". *First Language*. **25**: 292-293
8. ^ *a* *b* De Houwer, Annick (1990). *The acquisition of two languages from birth*: *A case study*. Cambridge: CUP
9. ^ *a* *b* *c* Hulk, Aafke; Müller, Natascha (2000). "Bilingual first language acquisition at the interface between syntax and pragmatics". *Bilingualism: Language and Cognition*. **3**: 227-244.
10. ^ Müller, Natascha; Hulk, Aafke (2001). "Crosslinguistic influence in bilingual language acquisition: Italian and French as recipient languages". *Bilingualism: Language and Cognition*. **4**: 1-53.
11. ^ Yip, Virginia; Matthews, Stephen (2006). "Assessing Language Dominance in Bilingual Acquisition: A Case for Mean Length Utterance Differentials". *Language Assessment Quarterly*. **3**: 101-102.
12. ^ *a* *b* *Yip, Virginia (2013). "6". Simultaneous Language Acquisition.*

Wiley-Blackwell.

13. ^ Notley, Anna (2005). *Romance Languages and Linguistic Theory 2005*. Benjamins. pp. 231-234.
14. ^ Nicoladis, Elena (2006). "Cross-linguistic transfer in adjective-noun strings by preschool bilingual children". *Bilingualism: Language and Cognition*. **9**: 17-26.
15. ^ ***a*** ***b*** ***c*** *Arabski, Janusz (2006). Cross-linguistic Influences in the Second Language Lexicon. Multilingual Matters. ISBN 9781853598562.*
16. ^ *Lee, T. (2016). "Dominant Language Transfer in the comprehension of L2 learners and heritage speakers". International Journal of Applied Linguistics.* ***26****: 190–210.*
17. ^ *Gass, Susan; Selinker, Larry (1992). Language Acquisition and Language Disorders : Language Transfer in Language Learning : Revised edition. Amsterdam, NL: John Benjamins Publishing Company. p. 32. ISBN 9789027224682.*
18. ^ ***a*** ***b*** ***c*** *Bussmann, H (1996). Routledge Dictionary of Language and Linguistics. London:Routledge.*
19. ^ ***a*** ***b*** ***c*** *Odlin, Terence (1989). Language Transfer – Cross-linguistic Influence in Language Learning. Cambridge: Cambridge University Press.*
20. ^ Schachter, J. (1974), AN ERROR IN ERROR ANALYSIS1. Language Learning, 24: 205–214. doi:10.1111/j.1467-1770.1974.tb00502.x
21. ^ ***a*** ***b*** *Kamimoto, T.; Shimura, A.; Kellerman, E. (1992). 'A second language classic reconsidered--the case of Schachter's avoidance'. Second Language Research 8: 231-77. pp. 231–77.*
22. ^ *Ellis, Rod (1994). The Study of Second Language Acquisition. Walton Street, Oxford: Oxford University Press. pp. 304–5. ISBN 0194371891.*
23. ^ ***a*** ***b*** *The New Cassell's French Dictionary: French-English, English-French. New York: Funk & Wagnalls Company. 1962. p. 122.*
24. ^ *Lamb, William. Scottish Gaelic (2nd Edition). Retrieved 18 April 2017.*
25. ^ *Bardovi-Harlig, Kathleen; Stringer, David (2010). "Variables in Second Language Attrition: Advancing the State of the Art". Studies in Second Language Acquisition.* ***32****: 1–45.*

26. ^ Grosjean, F. (1997). The bilingual individual. Interpreting, 2(1/2), 163-187
27. ^ Auer, Peter, and Li Wei. Handbook of Multilingualism and Multilingual Communication. Berlin: Mouton De Gruyter, 2009. Print.
28. ^ [a] [b] Argyri, Efrosyni; Sorace, Antonella (2007).Crosslinguistic influence and language dominance in older bilingual children. Bilingualism: Language and Cognition. 10(1), 79-99.
29. ^ [a] [b] Hauser-Grüdl, N., Guerra, L. A., Witzmann, F., Leray, E., & Müller, N. (2010). Cross-linguistic influence in bilingual children: Can input frequency account for it? Lingua, 120(11), 2638-2650. doi:10.1016/j.lingua.2010.06.008
30. ^ [a] [b] Jarvis, S., & Pavlenko, A. (2008). Crosslinguistic influence in language and cognition. London: Routledge.
31. ^ *Aronin, Larissa; Hufeisen, Britta (2009). "1". On the genesis and development of L3 research, multilingualism and multiple language acquisition. John Benjamins Publishing Company*.

Further reading

Gaston, P. (2013)Syntactic error processing in bilingualism: an analysis of the Optional Infinitive stage in child language acquisition (Unpublished doctoral dissertation). Yale University.

Odlin, T. (2005). Crosslinguistic Influence And Conceptual Transfer: What Are The Concepts? *Annual Review of Applied Linguistics*, *25*. doi:10.1017/s0267190505000012

Categories: Cognitive science | Multilingualism | Psycholinguistics | Second-language acquisition

Back to main TOC

Contents

Spatial contextual Awareness

Jump to navigation Jump to search

Spatial contextual awareness consociates contextual information such as an individual's or sensor's location, activity, the time of day, and proximity to other people or objects and devices.[1] It is also defined as the relationship between and synthesis of information garnered from the spatial environment, a cognitive agent, and a cartographic map. The spatial environment is the physical space in which the orientation or wayfinding task is to be conducted; the cognitive agent is the person or entity charged with completing a task; and the map is the representation of the environment which is used as a tool to complete the task.[2]

An incomplete view of spatial contextual awareness would render it as simply a contributor to or an element of contextual awareness – that which specifies a point location on the earth. This narrow definition omits the individual cognitive and computational functions involved in a complex geographic system. Rather than defining the myriad of potential factors contributing to context, spatial contextual awareness defined in terms of cognitive processes permits a unique, user-centered perspective in which "conceptualizations imbue spatial structures with meaning."[2]

Context awareness, geographic awareness, and ubiquitous cartography or Ubiquitous Geographic Information (UBGI) all contribute to the understanding of spatial contextual awareness. They are also key elements in a map-based, location-based service, or LBS. In cases in which the user interface for the LBS is a map, cartographic design challenges must be addressed in order to effectively communicate the spatial context to the user.

Spatial contextual awareness can describe present context – the environment of the user at the present time and location, or that of a future context – where the user wants to go and what may be of interest to them in the approaching spatial environment. Some location-based services are

proactive systems which can anticipate future context.[3] Augmented reality is an application which guides a user through present and into future context by displaying spatial contextual information in their visual system as they traverse through real space.[4]

Numerous examples of LBS applications exist which require the ability to leverage spatial contextual awareness. These applications are in demand by the general public and are examples of how maps are being used by individuals to help better understand the world and make daily decisions.[5]

TOP

TOC Next

Context awareness

Context awareness originated as a term from ubiquitous computing or as so-called pervasive computing which sought to deal with linking changes in the environment with computer systems, which are otherwise static.

Context is defined in multiple ways, most often with location as the cornerstone. One source defines it as "location and the identity of nearby people and objects." Another describes it as "location, identity, environment and time".[6] Yet some definitions recognize context awareness as being more inclusive than location.

Dey[7] took this broader approach: "context is any information that can be used to characterize the situation of an entity, where entity means a person, place, or object, which is relevant to the interaction between a user and an application, including the user and the applications themselves." The same author defined a system "to be context-aware if it uses context to provide relevant information and/or services to the user, in which the relevancy depends on the user's task".[7]

The concept of relevancy is described in the following definition of context awareness: "the set of environmental states and settings that either determines an application's behavior or in which an application event occurs and is interesting to the user".[1] Different levels of context, in terms of low and high level have also been outlined. Low-level contexts consist of time, location, network bandwidth and orientation. A high-level context consists of the user's current activity and social context.[1]

A three-level model of context awareness (Figure 1) includes the changeable nature of the environment by differentiating between the contributions of static, dynamic, and internal context:[8]

- Static context – stored digital geographic information which could impact the user's environment
- Dynamic context – information on the changeable aspects of the

user's environment obtained by sensors/info services and provided in real time (e.g. weather forecasts, traffic reports)
- Internal context – user information, to include personal preferences, location, speed, and orientation

Static content is driven by stored information while dynamic content is provided and updated by sensors.

Context categories for mobile maps have been identified through pilot user tests. The categories in Table 1 were deemed useful for mobile map services:[9]

Table 1:[9] Context Categories

TOC Previous Next

Geographic awareness

Geographic awareness, another term for spatial contextual awareness, clarifies the spatial and geographic aspects of context. Being more than simply present location, it must also include other dimensions and their interdependencies. Figure 2 shows Li's[8] components of context awareness and overlays them on multiple geographic reference systems. To be effective, an LBS application must be able to operate in a heterogeneous space which includes different reference systems. A user of a LBS must be able to seamlessly convert from a Euclidean space (Cartesian Reference Space), to a Linear Reference Space (LRS), to indoor space (to include perhaps the floor, wing, hallway, and room number).[10]

Ubiquitous geographic information (UBGI)/Ubiquitous cartography

Ubiquitous geographic information (UBGI) is geographic information which is provided at any time and any place to users or systems through communication devices. Critical to the understanding of UBGI is that the information provided is based on the context of the user. UBGI is more than data. It includes a set of concepts, practices and standards for spatial and geographic information and processing for applications accessible for use by the general public.[10]

UBGI must also take into account the situation and goals of the user, or cognitive agent. For that purpose, ubiquitous computing concepts employ sensors to collect data on the user's location as well as environmental parameters.[2]

Ubiquitous cartography is "the ability for users to create and use maps in any place and at any time to resolve geospatial problems".[11] The users and creators of these maps are more than just highly trained geographers and cartographers, but include the average citizen. In contrast to the accused elitism of the GIS community in the early 80's when many advocated for separate technology because geospatial information was different and unattainable to common users or systems, today's goal of ubiquity is to make the user experience with GIS-enabled devices intuitive and simple to use.[12] These devices and other multimedia cartography tools are playing a major role in the effort to get "maps out" to the general public and end the inexcusable practice of perfecting maps as a visualization form only for expert map users operating highly specialized Geographic Information Systems.[5]

The "ease-of-use" objective of ubiquitous cartography can be seen as the fourth generation in the evolution of geographic information. UBGI was preceded by easily accessible of internet maps and the addition of contextual information of LBS and mobile mapping. Digital geographic information was an essential precursor to accessible and mobile maps and

these advancements are all an outgrowth of the first generation of paper maps and the effort to better represent and visualize the world (Fig. 3).[10]

TOC Previous Next

Location-based services (LBS)

A location-based service (LBS) is an information and entertainment service, accessible with mobile devices through the mobile network and utilizing the ability to make use of the geographical position of the mobile device.

LBS services can be used in a variety of contexts, such as health, work, personal life, etc. LBS services include services to identify a location of a person or object, such as discovering the nearest banking cash machine or the whereabouts of a friend or employee. LBS services include parcel tracking and vehicle tracking services. LBS can include mobile commerce when taking the form of coupons or advertising directed at customers based on their current location. They include personalized weather services and even location-based games. They are an example of telecommunication convergence.

Location Based Services have the ability to exploit knowledge about the location of a user or an information device. Whether the output of the device is a simple text message or an interactive graphic map, the user and the user's location are in some way incorporated into the overall system.[11]

Other distinguishing characteristics of LBS include:[6]

- Usually provide personalized services for a user on-the-move
- Based on diverse hardware and software platforms which utilize the internet, GIS, and location-aware devices and telecommunication services
- Receive data from various sources, sensors and systems
- Must integrate and process data in real-time
- Pose unique challenges for visualization due to the fact that the user's location could be constantly changing

LBS can be used to answer user questions which can be placed into four general categories: location, proximity, navigation, and events. Examples include:[13]

- Where am I? Where is my destination? [location]
- Where is the nearest bus stop or fast food restaurant? [proximity]
- What is the best route to my destination? [navigation]
- Is the latest movie showing at the local theater? [events]

Another category is "measurement" to answer the question, how far away is my destination?[9] This is a routine function of personal automobile navigation devices.

New, innovative ideas continue to add to the types of questions in which LBS can answer for a user. For example, computer vision and object based indexing can be used to both identify an object and assist a user in navigating from the location. Spatial contextual awareness plays a key role in this process as it provides an initial geo-reference of the location while simplifying the object recognition process to a manageable degree.[14] This category of LBS use can be called "identification" and answers the question "What is it?"

Cartographic challenges

Applications which require the use of spatial contextual awareness in LBS are confronted with a multitude of cartographic challenges and decisions. Some of these challenges are due to the small displays of the typical PDA user interface and method of use.[15] Other problems result from the large volume of potentially relevant contextual data as difficult choices need to be made on the most important content to display.[16]

A sampling of some of these challenges are:

- Mobility – A map on a mobile platform is changing quickly to keep up with context changes; limited time to view map information before a change in scene may be required.[17]
- Adaptation – Refers to "the ability of flexible systems to be changed by the user or the system in order to meet specific requirements." Users must be able to personalize the display to present content adaptable to their sophistication and familiarity of the environment[17]
- Accessibility – "the matching of people's information and service needs with their needs and preferences in terms of intellectual and sensory engagement with that information or service, and control of it".[18] A service need could include a driver who cannot take their eyes off the road to study a map display; or a visitor in a foreign country who cannot understand the language of the audible cues of a LBS provider.
- Generalization – "Due to the very small display area of mobile devices mobile maps need to be extremely generalized." The design should simple, concise and self-evident as possible and should be instantly usable. "This means to lower the information density following the primacy of relevance over completeness"[17]
- Scaling – Map display is typically very small, requiring scaling functions to show enough area and information to be useful, but at a large enough scale to adequately show detail
- Relevance – "Presenting as much info as needed and as little as required".[16] The information which is "needed" is the content which

is effective for the particular spatial context of the user.

- Presentation Form – Multimedia maps provide several display medium options. The option selected should be the one which best generates the user's mental map. Besides the visual medium of a graphic map with representative symbols, textual and vocal presentations are options to consider.[19]
- Visual Variables – Color is an appropriate primary graphic element when portraying different type or classes of qualitative features.[20] Color can contribute enormously to the usability of products as it assists in differentiating between different screen elements.[21] High contrast, harmoniously matched colors need to be considered for quick perception and to reduce eye fatigue resulting from the radiant screen display[22]
- Metadata – Good metadata provides information to the user on the sources and quality of data being referenced to include reliability, accuracy, and authenticity. More useful and higher quality metadata for multimedia applications is an omnipresent challenge. International standards have been developed for geographic information, however, these "need to be extended and linked to information object metadata standards for photographs, videos, imagery, text, and other elements used by multimedia cartography".[23]
- Navigation Views – The determination on best map views to aid user navigation. Considerations include: overview maps available at various scales; automatic zoom to larger scale when user is in motion; maintain egocentric map position with north always marked.[24]

Applications

- Google Maps for mobile: Free download to view maps and satellite imagery, determine present location, business search, driving directions, and traffic reports
- Streamspin: Mobile services platform for delivery and receipt of information and services based on subscriber context and metadata.
- Local Location Assistant (Lol@): Prototype of a location-based multimedia service for a Universal Mobile Telecommunications System in which a foreign tourist can take a self-guided tour along a route based on user input and preferences.
- IPointer (Intelligent Spatial Technologies): Based on an augmented reality engine providing a local mobile client search to provide the user with information about their surroundings. Uses location and radial direction to identify a landmark of interest and stream information content.
- Signpost: A location-aware guide utility which uses computer vision technology to track fiducial markers for wide area indoor tracking. Signpost guides conference attendees through the venue with the use of a cell phone.

TOC | Previous | Next

See also

- Augmented reality
- Context awareness
- Context-aware pervasive systems
- Fiduciary marker
- Human-computer interaction
- Location awareness
- Location-based service
- Sense of direction
- Spatial ability
- Topology
- Ubiquitous computing

TOC | Previous | Next

References

1. ^ a b c Chen, Guanling, and David Kotz. 2000. A Survey of Context-Aware Mobile Computing Research. Dartmouth Computer Science Technical Report TR2000-381.
2. ^ a b c Freksa, Christian, Alexander Klippel, and Stephan Winter. 2005. A Cognitive Perspective on Spatial Context. Dagstuhl Seminar Proceedings 05491.
3. ^ Mayrhofer, Rene, Harald Radi, and Alois Ferscha. 2003. Recognizing and Predicting Context by Learning from User Behavior. In *The International Conference On Advances in Mobile Multimedia (MoMM2003)*, ed. W. Schreiner, G. Kotsis, A. Ferscha, and K. Ibrahim, volume 171, pages 25–35. Austrian Computer Society (OCG), September 2003.
4. ^ Gartner, Georg. 2007a. Development of Multimedia – Mobile and Ubiquitous. In *Multimedia Cartography*, ed. William Cartwright, Michael P. Peterson, and Georg Gartner, 51-62. Springer-Verlag Berlin Heidelberg.
5. ^ a b Peterson, Michael P. 2007a. Elements of Multimedia Cartography. In *Multimedia Cartography*, ed. William Cartwright, Michael P. Peterson, and Georg Gartner, 63-73. Springer-Verlag Berlin Heidelberg.
6. ^ a b Jiang, Bin, and Xiaobai Yao. 2007. Location Based Services and GIS in Perspective. In *Location Based Services and TeleCartography*, ed. Georg Gartner, William Cartwright, and Michael P. Peterson, 27-45. Springer-Verlag Berlin Heidelberg.
7. ^ a b Dey, Anind K. 2001. Understanding and Using Context. *Personal and Ubiquitous Computing*, Volume 5, 4-7. Springer London.
8. ^ a b c d Li, Ki-Joune. 2007. Ubiquitous GIS, Part I: Basic Concepts of Ubiquitous GIS, Lecture Slides, Pusan National University.
9. ^ a b c Nivala, Annu-Maaria, and L. Tiina Sarjakoski. 2003. Need for Context-Aware Topographic Maps in Mobile Devices, In ScanGIS'2003 -Proceedings of the 9th Scandinavian Research Conference on Geographical Information Science, June 4–6, Espoo,

Finland.
10. ^ *a* *b* *c* *d* Hong, Sang-Ki, 2008. Ubiquitous Geographic Information (UBGI) and address standards. ISO Workshop on address standards: Considering the issues related to an international address standard. 25 May 2008. Copenhagen, Denmark.
11. ^ *a* *b* Gartner, Georg. 2007b. LBS and TeleCartography: About the book. In *Location Based Services and TeleCartography,* ed. Georg Gartner, William Cartwright, and Michael P. Peterson, 1-11. Springer-Verlag Berlin Heidelberg.
12. ^ Herring, John R. n.d. Ubiquitous Geographic Information: Releasing GI from Its Ivory Tower, Oracle Corporation.
13. ^ Reichenbacher, Tumasch. 2001. The World in Your Pocket – Towards a Mobile Cartography. In Proceedings of the 20th International Cartographic Conference, August 6–10, Beijing, China, 4: 2514–2521.
14. ^ Luley, Patrick, Lucas Paletta, Alexander Almer, Mathias Schardt, Josef Ringert, 2007. Geo-Services and Computer Vision for Object Awareness in Mobile System Applications. In *Location Based Services and TeleCartography,* ed. Georg Gartner, William Cartwright, and Michael P. Peterson, 291-300. Springer-Verlag Berlin Heidelberg.
15. ^ Peterson, Michael P. 2007b. The Internet and Multimedia Cartography. In *Multimedia Cartography*, ed. William Cartwright, Michael P. Peterson, and Georg Gartner, 35-50. Springer-Verlag Berlin Heidelberg.
16. ^ *a* *b* Reichenbacher, Tumasch. 2007b. The concept of relevance in mobile maps. In Location Based Services and TeleCartography, ed. Georg Gartner, William Cartwright, and Michael P. Peterson, 231-246. Springer-Verlag Berlin Heidelberg.
17. ^ *a* *b* *c* Reichenbacher, Tumasch. 2007a. Adaptation in mobile and ubiquitous cartography. In Multimedia Cartography, ed. William Cartwright, Michael P. Peterson, and Georg Gartner, 383-397. Springer-Verlag Berlin Heidelberg.
18. ^ Nevile, Liddy, and Martin Ford. 2007. Location and Access: Issues Enabling Accessibility of Information. In *Multimedia Cartography*, ed. William Cartwright, Michael P. Peterson, and Georg Gartner, 471-485. Springer-Verlag Berlin Heidelberg.

19. ^ Gartner, Georg. and Verena Radoczky. 2007c. Maps and LBS – Supporting wayfinding by cartographic means. In Multimedia Cartography, ed. William Cartwright, Michael P. Peterson, and Georg Gartner, 369-382. Springer-Verlag Berlin Heidelberg.
20. ^ Robinson, Arthur H., Joel L. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill. 1995. *Elements of Cartography*, 381. John Wiley & Sons, Inc.
21. ^ Furey, Scott, and Kirk Mitchell. 2007. A Real-World implementation of Multimedia Cartography in LBS: The Whereis Mobile Application Suite. In Multimedia Cartography, ed. William Cartwright, Michael P. Peterson, and Georg Gartner, 399-414. Springer-Verlag Berlin Heidelberg.
22. ^ Wintges, Theodor. 2005. Geodata Communication on Personal Digital Assistants (PDA). In *Maps and the Internet*, ed. Michael P. Peterson, 397-402. Elsevier Ltd.
23. ^ Taylor, D.R. Fraser, and Tracey P. Lauriault. 2007. Future Directions for Multimedia Cartography. In *Multimedia Cartography*, ed. William Cartwright, Michael P. Peterson, and Georg Gartner, 505-522. Springer-Verlag Berlin Heidelberg.
24. ^ Radoczky, Verena. 2007. How to design a pedestrian navigation system for indoor and outdoor environments. In Location Based Services and TeleCartography, ed. Georg Gartner, William Cartwright, and Michael P. Peterson, 301-316. Springer-Verlag Berlin Heidelberg.

TOC Previous

External links

- Google Maps for mobile [1]
- Streamspin [2]
- Local Location Assistant (Lol@) [3]
- iPointer [4]
- Signpost [5]

Categories:

- User interface techniques
- Cognitive science

This page was last edited on 22 September 2016, at 04:02.

Back to main TOC

Contents

Cognitive Biology

Cognitive biology is an emerging science that regards natural cognition as a biological function.[1] It is based on the theoretical assumption that every organism—whether a single cell or multicellular—is continually engaged in systematic acts of cognition coupled with intentional behaviors, i.e., a sensory-motor coupling.[2] That is to say, if an organism can sense stimuli in its environment and respond accordingly, it is cognitive. Any explanation of how natural cognition may manifest in an organism is constrained by the biological conditions in which its genes survives from one generation to the next.[3] And since by Darwinian theory the species of every organism is evolving from a common root, three further elements of cognitive biology are required: (i) the study of cognition in one species of organism is useful, through contrast and comparison, to the study of another species' cognitive abilities;[4] (ii) it is useful to proceed from organisms with simpler to those with more complex cognitive systems,[5] and (iii) the greater the number and variety of species studied in this regard, the more we understand the nature of cognition.[6]

Overview

While cognitive science endeavors to explain human thought and the conscious mind, the work of cognitive biology is focused on the most fundamental process of cognition for any organism. In the past several decades, biologists have investigated cognition in organisms large[7] and small,[8] both plant[9] and animal.[10] “Mounting evidence suggests that even bacteria grapple with problems long familiar to cognitive scientists, including: integrating information from multiple sensory channels to marshal an effective response to fluctuating conditions; making decisions under conditions of uncertainty; communicating with conspecifics and others (honestly and deceptively); and coordinating collective behaviour to increase the chances of survival.”[11] Without thinking or perceiving as humans would have it, an act of basic cognition is arguably a simple step-by-step process through which an organism senses a stimulus, then finds an appropriate response in its repertoire and enacts the response. However, the biological details of such basic cognition have neither been delineated for a great many species nor sufficiently generalized to stimulate further investigation. This lack of detail is due to the lack of a science dedicated to the task of elucidating the cognitive ability common to all biological organisms. That is to say, a *science* of cognitive biology has yet to be established.[12] A prolegomena[13] for such science was presented in 2007 and several authors[14] have published their thoughts on the subject since the late 1970s. Yet as the examples in the next section suggest, there is neither consensus on the theory nor widespread application in practice.

Although the two terms are sometimes used synonymously,[15] cognitive biology should not be confused with the biology of cognition in the sense that it is used by adherents to the Chilean School of Biology of Cognition.[16] Also known as the Santiago School, the biology of cognition is based on the work of Francisco Varela and Humberto Maturana,[17] who crafted the doctrine of autopoiesis. Their work began in 1970 while the first mention of cognitive biology by Brian Goodwin (discussed below)

was in 1977 from a different perspective.[18]

History

'Cognitive biology' first appeared in the literature as a paper with that title by Brian C. Goodwin in 1977.[19] There and in several related publications[20] Goodwin explained the advantage of cognitive biology in the context of his work on morphogenesis. He subsequently moved on to other issues of structure, form, and complexity with little further mention of cognitive biology. Without an advocate, Goodwin's concept of cognitive biology has yet to gain widespread acceptance.

Aside from an essay regarding Goodwin's conception by Margaret Boden in 1980, the next appearance of 'cognitive biology' as a phrase in the literature came in 1986 from a professor of biochemistry, Ladislav Kováč. His conception, based on natural principles grounded in bioenergetics and molecular biology, is briefly discussed below. Kováč's continued advocacy has had a greater influence in his homeland, Slovakia, than elsewhere partly because several of his most important papers were written and published only in Slovakian.

By the 1990s, breakthroughs in molecular, cell, evolutionary, and developmental biology generated a cornucopia of data-based theory relevant to cognition. Yet aside from the theorists already mentioned, no one was addressing cognitive biology except for Kováč.

TOC Previous Next

Kováč's cognitive biology

Ladislav Kováč's "Introduction to cognitive biology" (Kováč, 1986a) lists ten 'Principles of Cognitive Biology.' A closely related thirty page paper was published the following year: "Overview: Bioenergetics between chemistry, genetics and physics." (Kováč, 1987). Over the following decades, Kováč elaborated, updated, and expanded these themes in frequent publications, including "Fundamental principles of cognitive biology" (Kováč, 2000), "Life, chemistry, and cognition" (Kováč, 2006a), "Information and Knowledge in Biology: Time for Reappraisal" (Kováč,

2007) and "Bioenergetics: A key to brain and mind" (Kováč, 2008).[21]

Academic usage

University seminar

The concept of cognitive biology is exemplified by this seminar description:[22]

University workgroup

The University of Adelaide has established a "Cognitive Biology" workgroup using this operating concept:

Members of the group study the biological literature on simple organisms (e.g., nematode) in regard to cognitive process and look for homologues in more complex organisms (e.g., crow) already well studied. This comparative approach is expected to yield simple cognitive concepts common to all organisms. “It is hoped a theoretically well-grounded toolkit of basic cognitive concepts will facilitate the use and discussion of research carried out in different fields to increase understanding of two foundational issues: **what cognition is** and **what cognition does** in the biological context.”[25] (Bold letters from original text.)

The group’s choice of name, as they explain on a separate webpage, might have been ‘embodied cognition’[26] or ‘biological cognitive science.’[27] But the group chose ‘cognitive biology’ for the sake of (i) emphasis and (ii) method. For the sake of emphasis, (i) “We want to keep the focus on biology because for too long cognition was considered a function that could be almost entirely divorced from its physical instantiation, to the extent that whatever could be said of cognition almost by definition had to be applicable to both organisms and machines.” (ii) The method is to “assume (if only for the sake of enquiry) that cognition is a biological function similar to other biological functions—such as respiration, nutrient

circulation, waste elimination, and so on."[28]

The method supposes that the genesis of cognition is biological, i.e., the method is *biogenic*. The host of the group's website has said elsewhere[29] that cognitive biology requires a biogenic approach, having identified ten principles of biogenesis in an earlier work.[30] The first four biogenic principles are quoted here to illustrate the depth at which the foundations have been set at the Adelaide school of cognitive biology:

1. "Complex cognitive capacities have evolved from simpler forms of cognition. There is a continuous line of meaningful descent."
2. "Cognition directly or indirectly modulates the physico-chemical-electrical processes that constitute an organism ."
3. "Cognition enables the establishment of reciprocal causal relations with an environment, leading to exchanges of matter and energy that are essential to the organism's continued persistence, well-being or replication."
4. "Cognition relates to the (more or less) continuous assessment of system needs relative to prevailing circumstances, the potential for interaction, and whether the current interaction is working or not."[31]

TOC Previous Next

Other universities

- As another example, the Department für Kognitionsbiologie[32] at the University of Vienna declares in its mission statement a strong commitment "to experimental evaluation of multiple, testable hypotheses" regarding cognition in terms of evolutionary and developmental history as well as adaptive function and mechanism, whether the mechanism is cognitive, neural, and/or hormonal. "The approach is strongly comparative: multiple species are studied, and compared within a rigorous phylogenetic framework, to understand the evolutionary history and adaptive function of cognitive mechanisms ('cognitive phylogenetics')."[33] Their website offers a sample of their work: "Social Cognition and the Evolution of Language: Constructing Cognitive Phylogenies."[34]

- A more restricted example can be found with the Cognitive Biology Group,[35] Institute of Biology, Faculty of Science, Otto-von-Guericke University (OVGU) in Magdeburg, Germany. The group offers courses titled “Neurobiology of Consciousness” and “Cognitive Neurobiology.”[36] Its website lists the papers generated from its lab work, focusing on the neural correlates of perceptual consequences and visual attention. The group’s current work is aimed at detailing a dynamic known as ‘multistable perception.’ The phenomenon, described in a sentence: “Certain visual displays are not perceived in a stable way but, from time to time and seemingly spontaneously, their appearance wavers and settles in a distinctly different form.”[37]
- A final example of university commitment to cognitive biology can be found at Comenius University in Bratislava, Slovakia. There in the Faculty of Natural Sciences, the Bratislava Biocenter is presented as a consortium of research teams working in biomedical sciences. Their website lists the Center for Cognitive Biology in the Department of Biochemistry at the top of the page, followed by five lab groups, each at a separate department of bioscience. The webpage for the Center for Cognitive Biology [38] offers a link to "Foundations of Cognitive Biology," a page that simply contains a quotation from a paper authored by Ladislav Kováč, the site’s founder. His perspective is briefly discussed below.

Cognitive biology as a category

The words ‘cognitive’ and ‘biology’ are also used together as the name of a category. The category of *cognitive biology* has no fixed content but, rather, the content varies with the user. If the content can only be recruited from *cognitive science*, then cognitive biology would seem limited to a selection of items in the main set of sciences included by the interdisciplinary concept—cognitive psychology, artificial intelligence, linguistics, philosophy, neuroscience, and cognitive anthropology.[39] These six separate sciences were allied “to bridge the gap between brain and mind” with an interdisciplinary approach in the mid-1970s.[40] Participating scientists were concerned only with human cognition. As it gained momentum, the growth of cognitive science in subsequent decades seemed to offer a big tent to a variety of researchers.[41] Some, for example, considered evolutionary epistemology a fellow-traveler. Others appropriated the keyword, as for example Donald Griffin in 1978, when he advocated the establishment of cognitive ethology.[42]

Meanwhile, breakthroughs in molecular, cell, evolutionary, and developmental biology generated a cornucopia of data-based theory relevant to cognition. Categorical assignments were problematic. For example, the decision to append *cognitive* to a body of biological research on neurons, e.g. the cognitive biology of neuroscience, is separate from the decision to put such body of research in a category named cognitive sciences. No less difficult a decision needs be made—between the computational and constructivist[43] approach to cognition, and the concomitant issue of simulated v. embodied[44] cognitive models—before appending biology to a body of cognitive research, e.g. the cognitive science of artificial life.

One solution is to consider *cognitive biology* only as a subset of *cognitive science*. For example, a major publisher’s website[45] displays links to material in a dozen domains of major scientific endeavor. One of which is described thus: “Cognitive science is the study of how the mind works, addressing cognitive functions such as perception and action, memory and

learning, reasoning and problem solving, decision-making and consciousness.” Upon its selection from the display, the *Cognitive Science* page offers in nearly alphabetical order these topics: *Cognitive Biology*, Computer Science, Economics, Linguistics, Psychology, Philosophy, and Neuroscience. Linked through that list of topics, upon its selection the *Cognitive Biology* page offers a selection of reviews and articles with biological content ranging from cognitive ethology[46] through evolutionary epistemology; cognition and art; evo-devo and cognitive science; animal learning; genes and cognition; cognition and animal welfare; etc.

A different application of the *cognitive biology* category is manifest in the 2009 publication of papers presented at a three-day interdisciplinary workshop on “The New Cognitive Sciences” held at the Konrad Lorenz Institute for Evolution and Cognition Research in 2006. The papers were listed under four headings, each representing a different domain of requisite cognitive ability: (i) space, (ii) qualities and objects, (iii) numbers and probabilities, and (iv) social entities. The workshop papers examined topics ranging from “Animals as Natural Geometers” and “Color Generalization by Birds” through “Evolutionary Biology of Limited Attention” and “A comparative Perspective on the Origin of Numerical Thinking” as well as “Neuroethology of Attention in Primates” and ten more with less colorful titles. “[O]n the last day of the workshop the participants agreed [that] the title ‘Cognitive Biology’ sounded like a potential candidate to capture the merging of the cognitive and the life sciences that the workshop aimed at representing.”[47] Thus the publication of Tommasi, et al. (2009), *Cognitive Biology: Evolutionary and Developmental Perspectives on Mind, Brain and Behavior*.

A final example of categorical use comes from an author’s introduction to his 2011 publication on the subject, *Cognitive Biology: Dealing with Information from Bacteria to Minds*. After discussing the differences between the cognitive and biological sciences, as well as the value of one to the other, the author concludes: “Thus, the object of this book should be considered as an attempt at building a new discipline, that of *cognitive biology*, which endeavors to bridge these two domains.”[48] There follows a detailed methodology illustrated by examples in biology anchored by

concepts from cybernetics (e.g., self-regulatory systems) and quantum information theory (regarding probabilistic changes of state) with an invitation "to consider system theory together with information theory as the formal tools that may ground biology and cognition as traditional mathematics grounds physics."[49]

TOC Previous Next

See also

- Cognitive anthropology
- Cognitive science of religion
- Cognitive neuropsychology
- Cognitive neuroscience
- Cognitive psychology
- Cognitive science
- Embodied cognitive science
- Embodied cognition
- Evolutionary epistemology
- Naturalized epistemology
- Neuroepistemology
- Spatial cognition

References & notes

1. ^ p133 in Lyon and Keijzer (2007).
2. ^ Van Duijn, et al. (2006). "Principles of minimal cognition: Casting cognition as sensorimotor coordination."
3. ^ Lyon and Opie (2007). “Prolegomena for a cognitive biology.”
4. ^ See for example Spetch and Friedman (2006), "Comparative cognition of object recognition.".
5. ^ Baluška and Mancuso (2009). Deep evolutionary origins of neurobiology: Turning the essence of ‘neural’ upside-down.
6. ^ Lyon (2013a) and visit the Comparative Cognition Society to enjoy their publication, *Comparative Cognition and Behavior Reviews*.
7. ^ [1]See for examples Byrne, et al. (2009), “Elephant cognition in primate perspective.”
8. ^ For instance, Ben Jacob, et al. (2006). "Seeking the foundations of cognition in bacteria.”
9. ^ As one example, see Calvo and Keijzer (2009), "Cognition in plants."
10. ^ *Comparative Cognition and Behavior Reviews*
11. ^ Lyon and Opie (2007), “Prolegomena for a cognitive biology.”
12. ^ There is no mention of cognitive biology, for example, in Frankish and Ramsey (2012), *The Cambridge Handbook of Cognitive Science*. Nor is cognitive biology mentioned in Margolis, et al.(2012), *The Oxford Handbook of Philosophy of Cognitive Science*.
13. ^ At the 2007 meeting of the International Society for the History, Philosophy and Social Studies of Biology, a paper was presented with the apt title: “Prolegomena for a cognitive biology.” See Lyon and Opie (2007).
14. ^ See Brian Goodwin and Ladislav Kováč, discussed below.
15. ^ See p135, 136, and 150 in Huber and Wilkinson (2012).
16. ^ http://www.inteco.cl/biology/
17. ^ Maturana (1970), “Biology of Cognition.”
18. ^ Goodwin (1977), "Cognitive biology." A copy of this four page paper is difficult to find. However, an eight page paper—Goodwin (1978), “A cognitive view of biological process,”—is easy to procure and uses his own 1977 paper as a reference. A study of the other

references in the ’78 paper suggests a unique perspective without mention of Maturana or Varela.

19. ^ Goodwin (1977) "Cognitive biology."
20. ^ Goodwin 1976a, 1976b, and 1978.
21. ^ Although many of his publications are difficult to find, this URL has them all: <http://www.biocenter.sk/lkpublics.html>.
22. ^ The seminar, titled "Cognitive Biology," was presented by Professor William Bechtel in the autumn of 2013 by the Department of Cognitive Science at the University of California, San Diego. The seminar description was followed by the schedule for ten sessions and citations for the several papers to be discussed in each session. The papers cover cognitive aspects for a broad range of motile organisms, beginning with two regarding the cognitive abilities of bacteria. Over the course of ten sessions, the speakers include six biologists, two doctors of psychology, and two doctors of philosophy. The initial session featured the presentation of a paper titled to evoke discussion, "Bacterial Information Processing: Is It Cognition?" The paper’s author and host of the seminar sessions was William Bechtel, a philosopher of science who has written extensively on the philosophy and history of cognitive science. See for example Bechtel, W., Abrahamsen, A. and Graham, G. (1998), ‘The life of cognitive science’, in ed. W. Bechtel and G. Graham, A Companion to Cognitive Science (Malden, MA and Oxford: Blackwell Publishers Ltd.), pp. 1–104. A more recent example: Abrahamsen, A. and Bechtel, W. (2012). History and core themes. In K. Frankish and W. Ramsey, The Cambridge Handbook of Cognitive Science. Cambridge University Press.
23. ^ In the preceding paragraph, neither mention nor definition of cognitive biology is made. Rather, context is established through the initial three sentences and an excellent description of cognitive biology is presented thereafter. The original seminar description was followed by the schedule for ten sessions and citations for the several papers to be discussed in each session. The papers cover cognitive aspects for a broad range of motile organisms, beginning with two regarding the cognitive abilities of bacteria. Over the course of ten sessions, the speakers include six biologists, two doctors of psychology, and two doctors of philosophy. The initial session

features a talk by Professor Bechtel titled to evoke discussion, "Bacterial Information Processing: Is It Cognition?"

24. ^ Lyon, Pamela (2013a). “Foundations for a Cognitive Biology.” Published on the homepage of the Cognitive Biology Project at the University of Adelaide. http://www.hss.adelaide.edu.au/philosophy/cogbio/
25. ^ Lyon, Pamela (2013a). “Foundations for a Cognitive Biology.” Published on the homepage of the Cognitive Biology Project at the University of Adelaide. http://www.hss.adelaide.edu.au/philosophy/cogbio/
26. ^ This option perpetuates a bias established by the original interdisciplinary grouping that formed the cognitive sciences in the 1970s: artificial intelligence, linguistics, neuroscience, philosophy, anthropology, and psychology. Clarification of cognition was slow in coming, even as computers and robots became more efficient. Some argued that a cognitive agent had to be embodied to interface with the world, thus excluding stationary computers. So a new member was added to the cognitive sciences, i.e., the science of embodied cognition. Both robot frogs and biological frogs were valid subjects for experiment.
27. ^ Such a name implies that this is just another cognitive science, one among equals.
28. ^ Lyon (2013b). “Why Cognitive Biology?” http://www.hss.adelaide.edu.au/philosophy/cogbio/why/.
29. ^ See also Lyon and Opie (2007) “Prolegomena for a cognitive biology.”
30. ^ More detail can be found in Lyon (2006), “The biogenic approach to cognition.”.
31. ^ See Lyon (2006), pps 15-20 for the principles quoted.
32. ^ This is the official website for the Department für Kognitionsbiologie: <http://cogbio.univie.ac.at/home>
33. ^ Department für Kognitionsbiologie COGBIO: Department of Cognitive Biology, Faculty of Life Sciences, University of Vienna, Austria
34. ^ [1]
35. ^ [2]

36. ^ Courses from the Cognitive Biology Group, Institute of Biology, Faculty of Science, OVGU (Otto-von-Guericke University) Magdeburg, Germany.
37. ^ Research at the Cognitive Biology Group, Institute of Biology, Faculty of Science, OVGU (Otto-von-Guericke University) Magdeburg, Germany.
38. ^ http://www.biocenter.sk/welcome1a.html
39. ^ Named on page 143 in Miller, George A. "The cognitive revolution: a historical perspective." Trends in cognitive sciences 7.3 (2003): 141-144.
40. ^ Named on page 143 in Miller, George A. "The cognitive revolution: a historical perspective." Trends in cognitive sciences 7.3 (2003): 141-144.
41. ^ See first page of Von Eckardt, Barbara. What is cognitive science?. MIT press, 1995.
42. ^ Griffin, Donald R. "Prospects for a cognitive ethology." Behavioral and Brain Sciences 1.04 (1978): 527-538.
43. ^ Stewart, J. (1996). Cognition = life: Implications for higher-level cognition. Behavioural Processes 35: 311-326.
44. ^ Ziemke, Tom (2003). What's that thing called embodiment. In Proceedings of the 25th Annual meeting of the Cognitive Science Society (pp. 1305-1310). Mahwah, NJ: Lawrence Erlbaum.
45. ^ [55] *WIRES* (Wiley Interdisciplinary Reviews) (2013). Wiley Online Library. John Wiley & Sons, Inc. http://wires.wiley.com/WileyCDA/
46. ^ For consideration of cogbio v cogetho, see p23 in Kamil (1998), “On the Proper Definition of Cognitive Ethology”.
47. ^ Tommasi, et al., page x in Preface. See pps 3-11 for a discussion of cognitive science and biology.
48. ^ Author’s italics, p2 in Auletta (2011), Cognitive biology: dealing with information from bacteria to minds.
49. ^ Auletta (2011), p61. See also, for examples, pps 335 & 340.

Bibliography

- Auletta, Gennaro (2011). Cognitive biology: dealing with information from bacteria to minds. Oxford University Press.
- Baluška, František and Stefano Mancuso (2009). Deep evolutionary origins of neurobiology: Turning the essence of ‘neural’ upside-down. Commun Integr Biol. Jan-Feb; 2(1): 60–65.
- Bechtel, William (2013). Seminar description for "Cognitive Biology" in the "Cognitive Science 200" series for "Fall, 2013" at University of California, San Diego, <http://mechanism.ucsd.edu/teaching/f13/cs200/>. See also http://mechanism.ucsd.edu/teaching/f13/cs200/bacterialinformationprocessing.pdf.
- Ben Jacob, Eshel, Yoash Shapira, and Alfred I. Tauber (2006). "Seeking the foundations of cognition in bacteria: From Schrödinger's negative entropy to latent information." Physica A: Statistical Mechanics and its Applications 359: 495-524.
- Bird, Angela (2010). Review - Cognitive Biology: Evolutionary and Developmental Perspectives on Mind, Brain, and Behavior
- by Luca, Tommasi, Mary A. Peterson and Lynn Nadel (Editors, MIT Press, 2009). Metapsychology Online Reviews, Volume 14, Issue 3.
- Boden, Margaret A (2006). Mind as machine: A history of cognitive science. Vol. 1. Oxford University Press.
- Boden, Margaret and Susan K Zaw (1980). “The case for a cognitive biology.” Proceedings of the Aristotelian Society, 54: 25–71.
- Byrne, R. W., Bates, L. A., Moss, C. J. (2009). “Elephant cognition in primate perspective.” Comparative Cognition & Behavior Reviews, 4, 65-79. Retrieved from http://arquivo.pt/wayback/20160520170354/http://comparative-cognition-and-behavior-reviews.org/index.html doi:10.3819/ccbr.2009.40009
- Calvo, Paco, and Fred Keijzer (2009). "Cognition in plants." Plant-environment interactions: Signaling & communication in plants: 247-266.
- Chomsky, N. (1972). Problems of Knowledge and Freedom. London: Fontana.
- Denton, Michael J., Craig J. Marshall, and Michael Legge (2002). "The protein folds as platonic forms: new support for the pre-Darwinian conception of evolution by natural law." Journal of Theoretical Biology 219.3: 325-342.
- Emmeche, Claus. "Life as an abstract phenomenon: Is artificial life possible?" (1992). Pages 466-474 in Francisco J. Varela and Paul Bourgine (eds.):Toward a Practice of Autonomous Systems. Proceedings of the First European Conference on Artificial Life. The MIT Press.
- Frankish, Keith, and William Ramsey, editors (2012). The Cambridge Handbook of Cognitive

Science. Cambridge University Press.

- Goodwin, Brian C (1976a). Analytical Physiology of Cells and Developing Organisms. London: Academic Press.
- Goodwin, Brian C (1976b). "On some relationships between embryogenesis and cognition." Theoria to Theory 10: 33-44.
- Goodwin, Brian C (1977). "Cognitive biology." Communication & Cognition. Vol 10(2), 87-91. This paper also appeared the same year in deMey, M, R. Pinxten, M. Poriau & F. Vandamme (Eds.), CC77 International Workshop on the Cognitive Viewpoint, University of Ghent Press, London, pp. 396–400.
- Goodwin, Brian C (1978). “A cognitive view of biological process.” J Soc Biol Structures 1:117-125
- Griffin, Donald R. "Prospects for a cognitive ethology." Behavioral and Brain Sciences 1.04 (1978): 527-538.
- Huber, Ludwig and Anna Wilkinson. "Evolution of cognition: A comparative approach." Chapter 8 in Sensory Perception. Springer Vienna, 2012. 135-152.
- Kamil, Alan C. (1998). "On the proper definition of cognitive ethology." Animal cognition in nature. Academic Press, San Diego 1-28.
- Kováč, Ladislav (1986a). “Úvod do kognitívnej biológie.” (Published in Slovak with an abstract in English, the title translates as an “Introduction to cognitive biology.”) Biol. listy 51: 172- 190. {Since old copies of Biologické listy are hard to find, see Kováč (2004a) for the republished version which is also in Slovak. Google translates it into English well enough, with some help from the reader using the Google translation tool.}
- Kováč, Ladislav (1986b). The future of bioenergetics. EBEC Reports 4: 26 - 27.
- Kováč, Ladislav (1987). “Overview: Bioenergetics between chemistry, genetics and physics.” Curr. Topics Bioenerg. 15: 331- 372.
- Kováč, Ladislav (2000). "Fundamental principles of cognitive biology." Evolution and cognition 6.1: 51-69. Evolution and Cognition was published by the Konrad Lorenz Institute for Evolution and Cognition Research (KLI) from 1995-2004. That journal was succeeded by a journal titled Biological Theory: Integrating Development, Evolution and Cognition. The paper is archived at this URL < http://www.biocenter.sk/lkpublics_files/C-7.pdf >.
- Kováč, Ladislav (2006a). “Life, chemistry, and cognition.” EMBO Reports 7, 562- 566
- Kováč, Ladislav (2006b) “Princípy molekulárnej kognície.” Kognice an umělý život VI : 215-222. Translation: “Principles of Molecular Cognition.” Cognition and Artificial Life VI: pp. 215–222
- Kovác, Ladislav (2007). "Information and Knowledge in Biology: Time for Reappraisal.” Plant Signaling & Behavior 2:2, 65-73

- Kovác, Ladislav (2008). "Bioenergetics: A key to brain and mind." Communicative & integrative biology 1.1: 114-122.
- Lyon, Pamela (2006), 'The biogenic approach to cognition', Cognitive Processing 7(1), 11–29.
- Lyon, Pamela (2013a). Foundations for a Cognitive Biology. Published on the homepage of the Cognitive Biology Project at the University of Adelaide. http://www.hss.adelaide.edu.au/philosophy/cogbio/
- Lyon, Pamela (2013b). Why Cognitive Biology? Published on an html page linked to Lyon (2013a). http://www.hss.adelaide.edu.au/philosophy/cogbio/why/
- Lyon, Pamela C and Jonathan P Opie (2007). "Prolegomena for a cognitive biology." A conference paper presented at the Proceedings of the 2007 Meeting of International Society for the History, Philosophy and Social Studies of Biology, University of Exeter. Abstract at http://hdl.handle.net/2440/46578.
- Lyon, Pamela, and Fred Keijzer (2007). "The human stain." Pages 132-165 in Wallace, Brendan editor. The mind, the body, and the world: psychology after cognitivism?. Imprint Academic, 2007
- Mandler, George (2002). "Origins of the cognitive (r)evolution". Journal of the History of the Behavioral Sciences 38 (4): 339–353. doi:10.1002/jhbs.10066. PMID 12404267.
- Margolis, Eric, Richard Samuels, and Stephen P. Stich, editors (2012). The Oxford Handbook of Philosophy of Cognitive Science. Oxford University Press.
- Maturana, Humberto R. (1970). "Biology of Cognition." Biological Computer Laboratory Research Report BCL 9.0. Urbana IL: University of Illinois. Reprinted in: Autopoiesis and Cognition: The Realization of the Living. Dordecht: D. Reidel Publishing Co., 1980, pp. 5–58.
- Miller, George A. "The cognitive revolution: a historical perspective." Trends in cognitive sciences 7.3 (2003): 141-144.
- Prigogine, Ilya (1980). From Being to Becoming. Freeman, San Francisco.
- Shapiro, J.A. (2007). "Bacteria are small but not stupid: cognition, natural genetic engineering and socio-bacteriology." Stud. Hist. Phil. Biol. & Biomed. Sci., Vol. 38: 807–819.
- Shapiro, J.A. (2011). Evolution: A View from the 21st Century, FT Press Science, NJ, USA.
- Spetch, Marcia L., and Alinda Friedman (2006). "Comparative cognition of object recognition." Comparative Cognition & Behavior Reviews 1: 12-35.
- Spitzer, Jan, and Bert Poolman (2009). "The role of biomacromolecular crowding, ionic strength, and physicochemical gradients in the complexities of life's emergence." Microbiology and Molecular Biology Reviews 73.2: 371-388.
- Stahlberg, Rainer (2006) "Historical Overview on Plant Neurobiology." Plant Signaling & Behavior 1:1, 6-8.
- Stotz, Karola, and Colin Allen. "From cell-surface receptors to higher learning: A whole world of

experience." In Philosophy of behavioral

- biology, pp. 85–123. Springer Netherlands, 2012.
- Tommasi, Luca, Mary A. Peterson, and Lynn Nadel, eds. (2009). Cognitive Biology: Evolutionary and Developmental Perspectives on Mind, Brain and Behavior. The MIT Press.
- Tinbergen, N. (1963). On aims and methods in ethology. Zeitschrift fur Tierpsychologie, 20, 410-433.
- Van Duijn, Marc, Fred Keijzer, and Daan Franken. "Principles of minimal cognition: Casting cognition as sensorimotor coordination." Adaptive Behavior14.2 (2006): 157-170.
- Von Eckardt, Barbara. What is cognitive science?. MIT press, 1995.
- Wasserman, Edward A. (1993). "Comparative cognition: Beginning the second century of the study of animal intelligence." Psychological Bulletin 113.2: 211
- Webster, Gerry, and Brian C. Goodwin (1982). "The origin of species: a structuralist approach." Journal of Social and Biological Structures 5.1: 15-47.
- Webster, Gerry, and Brian Goodwin (1996). Form and transformation: generative and relational principles in biology. Cambridge University Press.
- Whitehead, Alfred North. (1929). Process and Reality. Cambridge University Press.
- WIRES (Wiley Interdisciplinary Reviews) http://wires.wiley.com/WileyCDA/ (2013). Wiley Online Library. John Wiley & Sons, Inc.
- Zentall, Thomas R., Edward A. Wasserman, Olga F. Lazareva, Roger KR Thompson, and Mary Jo Rattermann (2008). "Concept learning in animals." Comp Cogn Behav Rev 3: 13-45.

External links

- European Network for the Advancement of Artificial Cognitive Systems, Interaction and Robotics
- Comparative Cognition and Behavior Reviews
- Ladislav Kováč's Publications

Categories: Cognition | Cognitive psychology | Cognitive science | Branches of biology | Plant cognition

This page was last edited on 31 August 2017, at 07:51.

Laws of Association

Jump to navigation Jump to search

The principal **laws of association** are contiguity, repetition, attention, pleasure-pain, and similarity. The basic laws were formulated by Aristotle in approximately 300 B.C. and by John Locke in the seventeenth century. Both philosophers taught that the mind at birth is a blank slate and that all knowledge has to be acquired by learning. The laws they taught still make up the backbone of modern learning theory.[1]

David Hartley taught that *contiguity* is the main law of association, and, believing that it is the primary source, Hartley ignored David Hume's law of resemblance (Warren, 1921).[1]

References

1. ^ *a* *b* Laws of Association - *Dictionary of Cognitive Science* - Dr. Michael R.W. Dawson and Dr. David A. Medler. Retrieved 8 March 2012.

TOP

Categories:

- Aristotle
- Cognitive science

This page was last edited on 14 May 2018, at 19:15.

Back to main TOC

Contents

Approximate number System

Jump to navigation Jump to search

The **approximate number system** (**ANS**) is a cognitive system that supports the estimation of the magnitude of a group without relying on language or symbols. The ANS is credited with the non-symbolic representation of all numbers greater than four, with lesser values being carried out by the parallel individuation system, or object tracking system.[1] Beginning in early infancy, the ANS allows an individual to detect differences in magnitude between groups. The precision of the ANS improves throughout childhood development and reaches a final adult level of approximately 15% accuracy, meaning an adult could distinguish 100 items versus 115 items without counting.[2] The ANS plays a crucial role in development of other numerical abilities, such as the concept of exact number and simple arithmetic. The precision level of a child's ANS has been shown to predict subsequent mathematical achievement in school.[3] The ANS has been linked to the intraparietal sulcus of the brain.[4]

TOP

TOC Next

History

TOC Next

Piaget's theory

Jean Piaget was a Swiss developmental psychologist who devoted much of his life to studying how children learn. A book summarizing his theories on number cognition, *The Child's Conception of Number*, was published in 1952.[2] Piaget's work supported the viewpoint that children do not have a stable representation of number until the age of six or seven. His theories indicate that mathematical knowledge is slowly gained and during infancy any concept of sets, objects, or calculation is absent.[2]

TOC Previous Next

Challenging the Piagetian viewpoint

Piaget's ideas pertaining to the absence of mathematical cognition at birth have been steadily challenged. The work of Rochel Gelman and C. Randy Gallistel among others in the 1970s suggested that preschoolers have intuitive understanding of the quantity of a set and its conservation under non cardinality-related changes, expressing surprise when objects disappear without an apparent cause.[2]

TOC Previous Next

Current theory

Beginning as infants, people have an innate sense of approximate number that depends on the ratio between sets of objects.[5] Throughout life the ANS becomes more developed, and people are able to distinguish between groups having smaller differences in magnitude.[6] The ratio of distinction is defined by Weber's law, which relates the different intensities of a sensory stimulus that is being evaluated.[7] In the case of the ANS, as the ratio between the magnitudes increases, the ability to discriminate between the two quantities increases.

Today, some theorize that the ANS lays the foundation for higher-level arithmetical concepts. Research has shown that the same areas of the brain are active during non-symbolic number tasks in infants and both non-symbolic and more sophisticated symbolic number tasks in adults.[8] These results could suggest that the ANS contributes over time to the development of higher-level numerical skills that activate the same part of the brain.

However, longitudinal studies do not necessarily find that non-symbolic abilities predict later symbolic abilities. Conversely, early symbolic number abilities have been found to predict later non-symbolic abilities, not vice versa as predicted.[9] In adults for example, non-symbolic number abilities do not always explain mathematics achievement.[10]

Neurological basis

Brain imaging studies have identified the parietal lobe as being a key brain region for numerical cognition.[11] Specifically within this lobe is the intraparietal sulcus which is "active whenever we think about a number, whether spoken or written, as a word or as an Arabic digit, or even when we inspect a set of objects and think about its cardinality".[2] When comparing groups of objects, activation of the intraparietal sulcus is greater when the difference between groups is numerical rather than an alternative factor, such as differences in shape or size.[5] This indicates that the intraparietal sulcus plays an active role when the ANS is employed to approximate magnitude.

Parietal lobe brain activity seen in adults is also observed during infancy during non-verbal numerical tasks, suggesting that the ANS is present very early in life.[6] A neuroimaging technique, functional Near-Infrared Spectroscopy, was performed on infants revealing that the parietal lobe is specialized for number representation before the development of language.[6] This indicates that numerical cognition may be initially reserved to the right hemisphere of the brain and becomes bilateral through experience and the development of complex number representation.

It has been shown that the intraparietal sulcus is activated independently of the type of task being performed with the number. The intensity of activation is dependent on the difficulty of the task, with the intraparietal sulcus showing more intense activation when the task is more difficult.[2] In addition, studies in monkeys have shown that individual neurons can fire preferentially to certain numbers over others.[2] For example, a neuron could fire at maximum level every time a group of four objects is seen, but will fire less to a group three or five objects.

TOC Previous Next

Pathology

Damage to intraparietal sulcus

Damage done to parietal lobe, specifically in the left hemisphere, can produce difficulties in counting and other simple arithmetic.[2] Damage directly to the intraparietal sulcus has been shown to cause acalculia, a severe disorder in mathematical cognition.[5] Symptoms vary based the location of damage, but can include the inability to perform simple calculations or to decide that one number is larger than another.[2] Gerstmann syndrome, a disease resulting in lesions in the left parietal and temporal lobes, results in acalculia symptoms and further confirms the importance of the parietal region in the ANS.[12]

Developmental delays

A syndrome known as dyscalculia is seen in individuals who have unexpected difficulty understanding numbers and arithmetic despite adequate education and social environments.[13] This syndrome can manifest in several different ways from the inability to assign a quantity to Arabic numerals to difficulty with times tables. Dyscalculia can result in children falling significantly behind in school, regardless of having normal intelligence levels.

In some instances, such as Turner syndrome, the onset of dyscalculia is genetic. Morphological studies have revealed abnormal lengths and depths of the right intraparietal sulcus in individuals suffering from Turner syndrome.[13] Brain imaging in children exhibiting symptoms of dyscalculia show less gray matter or less activation in the intraparietal regions stimulated normally during mathematical tasks.[2] Additionally, impaired ANS acuity has been shown to differentiate children with dyscalculia from their normally-developing peers with low maths

achievement.[14]

Further research and theories

Impact of the visual cortex

The intraparietal region relies on several other brain systems to accurately perceive numbers. When using the ANS we must view the sets of objects in order to evaluate their magnitude. The primary visual cortex is responsible for disregarding irrelevant information, such as the size or shape of the objects.[2] Certain visual cues can sometimes affect how the ANS functions.

Arranging the items differently can alter the effectiveness of the ANS. One arrangement proven to influence the ANS is visual nesting, or placing the objects within one another. This configuration affects the ability to distinguish each item and add them together at the same time. The difficulty results in underestimation of the magnitude present in the set or a longer amount of time needed to perform an estimate.[15]

Another visual representation that affects the ANS is the spatial-numerical association response code, or the SNARC effect. The SNARC effect details the tendency of larger numbers to be responded to faster by the right hand and lower numbers by the left hand, suggesting that the magnitude of a number is linked to a spatial representation.[16] Dehaene and other researchers believe this effect is caused by the presence of a “mental number line” in which small numbers appear on the left and increase as you move right.[16] The SNARC effect indicates that the ANS works more effectively and accurately if the larger set of objects is on the right and the smaller on the left.

Development and mathematical performance

Although the ANS is present in infancy before any numerical education, research has shown a link between people's mathematical abilities and the

accuracy in which they approximate the magnitude of a set. This correlation is supported by several studies in which school-aged children's ANS abilities are compared to their mathematical achievements. At this point the children have received training in other mathematical concepts, such as exact number and arithmetic.[17] More surprisingly, ANS precision before any formal education accurately predicts better math performance. A study involving 3-5 year old children revealed that ANS acuity corresponds to better mathematical cognition while remaining independent of factors that may interfere, such as reading ability and the use of Arabic numerals.[18]

TOC Previous Next

ANS in animals

Main article: Number sense in animals

Many species of non-human animals exhibit the ability to assess and compare magnitude. This skill is believed to be a product of the ANS. Research has revealed this capability in both vertebrate and non-vertebrate animals including birds, mammals, fish, and even insects.[19] In primates, implications of the ANS have been steadily observed through research. One study involving lemurs showed that they were able to distinguish groups of objects based only on numerical differences, suggesting that humans and other primates utilize a similar numerical processing mechanism.[20]

In a study comparing students to guppies, both the fish and students performed the numerical task almost identically.[19] The ability for the test groups to distinguish large numbers was dependent on the ratio between them, suggesting the ANS was involved. Such results seen when testing guppies indicate that the ANS may have been evolutionarily passed down through many species.[19]

TOC Previous Next

Applications in society

Implications for the classroom

Understanding how the ANS affects students' learning could be beneficial for teachers and parents. The following tactics have been suggested by neuroscientists to utilize the ANS in school:[2]

- Counting or abacus games
- Simple board games
- Computer-based number association games
- Teacher sensitivity and different teaching methods for different learners

Such tools are most helpful in training the number system when the child is at an earlier age. Children coming from a disadvantaged background with risk of arithmetic problems are especially impressionable by these tactics.[2]

References

1. ^ *Piazza, M. (2010). "Neurocognitive start-up tools for symbolic number representations". Trends in Cognitive Sciences.* ***14****: 542–551. doi:10.1016/j.tics.2010.09.008.*
2. ^ a b c d e f g h i j k l m *Sousa, David (2010). Mind, Brain, and Education: Neuroscience Implications for the Classroom. Solution Tree Press. ISBN 9781935249634.*
3. ^ *Mazzocco, M.M.M.; Feigenson, L.; Halberda, J. (2011). "Preschoolers' precision of the approximate number system predicts later school mathematics performance". PLoS ONE.* ***6*** *(9): e23749. doi:10.1371/journal.pone.0023749. PMC 3173357 . PMID 21935362.*
4. ^ *Piazza, M. (2004). "Tuning curves for approximate numerosity in the human parietal cortex". Neuron.* ***44****: 547–555. doi:10.1016/j.neuron.2004.10.014.*
5. ^ a b c *Cantlon, JF (2006). "Functional Imaging of Numerical Processing in Adults and 4-y-old Children". PLoS Biology.* ***4*** *(5): e125. doi:10.1371/journal.pbio.0040125. PMC 1431577 . PMID 16594732.*
6. ^ a b c *Hyde, DC (2010). "Near-infrared spectroscopy shows right parietal specialization for number in pre-verbal infants". NeuroImage.* ***53*** *(2): 647–652. doi:10.1016/j.neuroimage.2010.06.030. PMC 2930081 . PMID 20561591.*
7. ^ *Pessoa, L; Desimone R. (2003). "From Humble Neural Beginnings Comes Knowledge of Numbers". Neuron.* ***37*** *(1): 4–6. doi:10.1016/s0896-6273(02)01179-0.*
8. ^ *Piazza, M (2007). "A magnitude code common to numerosity and number symbols in human intraparietal cortex". Neuron.* ***53*** *(2): 293–305. doi:10.1016/j.neuron.2006.11.022.*
9. ^ *Mussolin, Christophe; Nys, Julie; Content, Alain; Leybaert, Jacqueline (2014-03-17). "Symbolic Number Abilities Predict Later Approximate Number System Acuity in Preschool Children". PLoS ONE.* ***9*** *(3): e91839. doi:10.1371/journal.pone.0091839. PMC 3956743 . PMID 24637785.*

10. ^ *Inglis, Matthew; Attridge, Nina; Batchelor, Sophie; Gilmore, Camilla (2011-12-01). "Non-verbal number acuity correlates with symbolic mathematics achievement: but only in children". Psychonomic Bulletin & Review.* ***18*** *(6): 1222–1229. doi:10.3758/s13423-011-0154-1. ISSN 1531-5320. PMID 21898191.*
11. ^ *Dehaene, S (2003). "Three parietal circuits for number processing". Cognitive Neuropsychology.* ***20*** *(3): 487–506. doi:10.1080/02643290244000239. PMID 20957581.*
12. ^ *Ashkenazi, S (2008). "Basic Numerical Processing in Left Intraparietal Sulcus (IPS) Acalculia". Cortex.* ***44*** *(4): 439–448. doi:10.1016/j.cortex.2007.08.008. PMID 18387576.*
13. ^ ***a*** ***b*** *Molko, N (2003). "Functional and structural alterations of the intraparietal sulcus in a developmental dyscalculia of genetic origin". Neuron.* ***40*** *(4): 847–858. doi:10.1016/s0896-6273(03)00670-6.*
14. ^ *Mazzocco, M.M.M.; Feigenson, L.; Halberda, J. (2011). "Impaired Acuity of the Approximate Number System Underlies Mathematical Learning Disability(Dyscalculia)". Child Development.* ***82*** *(4): 1224–1237. doi:10.1111/j.1467-8624.2011.01608.x. PMC 4411632 . PMID 21679173.*
15. ^ *Chesney, DL (2012). "Visual Nesting Impacts Approximate Number System Estimation". Attention, Perception, & Psychophysics.* ***74*** *(6).*
16. ^ ***a*** ***b*** *Ren, P (2011). "Size matters: non-numerical magnitude affects the spatial coding of response". PLOS ONE.* ***6*** *(8): e23553. doi:10.1371/journal.pone.0023553. PMC 3154948 . PMID 21853151.*
17. ^ *Halberda, J (2008). "Individual differences in non-verbal number acuity correlate with maths achievement". Nature.* ***455*** *(7213): 665–8. doi:10.1038/nature07246. PMID 18776888.*
18. ^ *Libertus, ME (2011). "Preschool acuity of the approximate number system correlates with school math ability". Developmental Science.* ***14*** *(6): 1292–1300. doi:10.1111/j.1467-7687.2011.01080.x. PMC 3338171 .*
19. ^ ***a*** ***b*** ***c*** *Agrillo, Christian (2012). "Evidence for Two Numerical Systems That Are Similar in Humans and Guppies". PLoS ONE.* ***7*** *(2): e31923. doi:10.1371/journal.pone.0031923. PMC 3280231 . PMID 22355405.*
20. ^ *Merritt, Dustin (2011). "Numerical rule-learning in ring-tailed Lemurs (Lemur catta)". Frontiers in Psychology.* ***2*** *(23).*

doi:10.3389/fpsyg.2011.00023.

Categories:

- Cognitive science
- Perception

This page was last edited on 15 May 2018, at 21:08.

Back to main TOC

Contents

Malleability of Intelligence

Jump to navigation Jump to search

Malleability of intelligence describes the processes by which intelligence can increase or decrease over time and is not static. These changes may come as a result of genetics, pharmacological factors, psychological factors, behavior, or environmental conditions. Malleable intelligence may refer to changes in cognitive skills, memory, reasoning, or muscle memory related motor skills. In general, the majority changes in human intelligence occurs at either the onset of development, during the critical period, or during old age (see Neuroplasticity).

Charles Spearman, who coined the general intelligence factor "g", described intelligence as one's ability to adapt to his environment with a set of useful skills including reasoning and understanding patterns and relationships. He believed individuals highly developed in one intellectual ability tended to be highly developed at other intellectual abilities. A more intelligent individual was thought to be able to more easily "accommodate" experiences into existing cognitive structures to develop structures more compatible with environmental stimuli.[1]

In general, intelligence is thought to be attributed to both genetic and environmental factors, but the extent to which each plays a key role is highly disputed. Studies of identical and non-identical twins raised separately and together show a strong correlation between child IQ and socio-economic level of the parents. Children raised in lower-class families tend to score lower on intelligence tests when compared to children raised in both middle and upper-class families. However, there is no difference in intelligence scores between children raised in middle versus upper-class families.[2]

TOP

Definitions

- **Intelligence**: a very general capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience.[3]
- **Critical period**: a restricted developmental period during which the nervous system is particularly sensitive to the effects of experience .[4]

Neuroscience basis

The biological basis of intelligence is founded in the degree of connectivity of neurons in the brain and the varying amounts of white and grey matter. Studies show that intelligence is positively correlated with total cerebral volume.[1] While it is true that the number of neurons in the brain actually decreases throughout development, as neural connections grow and the pathways become more efficient, the supporting structures in the brain increase. This increase in supporting tissues, which include myelination, blood vessels, and glial cells, leads to an increase in overall brain size.[1] When brain circumference and IQ were compared in 9 year olds, a positive correlation was found between the two. An increase of 2.87 IQ points occurred for each standard deviation increase in brain circumference.[5]

TOC Previous Next

Importance of critical period

The brain grows rapidly for the first five years of human development. At age five, the human brain is 90% of its total size. Then the brain finishes growing gradually until age twenty. From start to finish, the brain increases in size by over 300% from birth.[2] The critical period, defined as the beginning years of brain development, is essential to intellectual development, as the brain optimizes the overproduction of synapses present at birth.[2] During the critical period, the neuronal pathways are refined based on which synapses are active and receiving transmission. It is a "use it or lose it" phenomenon.[2]

TOC Previous Next

Neural plasticity

Neural plasticity refers to any change in the structure of the neural network that forms the central nervous system. Neural plasticity is the neuronal basis for changes in how the mind works, including learning, the

formation of memory, and changes in intelligence. One well-studied form of plasticity is Long-Term Potentiation (LTP).[6] It refers to a change in neural connectivity as a result of high activation on both sides of a synaptic cleft. This change in neural connectivity allows information to be more easily processed, as the neural connection associated with that information becomes stronger through LTP.[2] Other forms of plasticity involve the growth of new neurons, the growth of new connections between neurons, and the selective elimination of such connection, called "dendritic pruning".[7]

TOC Previous Next

Genetic factors of intelligence

Humans have varying degrees of neuroplasticity due to their genetic makeups, which affects their ability to adapt to conditions in their environments and effectively learn from experiences.[1] The degree to which intelligence test scores can be linked to genetic heritability *increases* with age. There is presently no explanation for this puzzling result, but flaws in the testing methods are suspected. A study of Dutch twins concludes that intelligence of 5 year olds is 26% heritable, while the test scores of 12-year-olds is 64% heritable. Structurally, genetic influences explain 77–88% of the variance in the thickness of the mid-sagittal area of the corpus callosum, the volume of the caudate nucleus, and the volumes of the parietal and temporal lobes.[3]

TOC Previous Next

Pharmacological influence

Numerous pharmacological developments have been made to help organize neural circuitry for patients with learning disorders. The cholinergic and glutamatergic systems in the brain serve an important role in learning, memory, and the developmental organization of neuronal circuitry. These systems help to capitalize on the critical period and organize synaptic transmission. Autism and other learning disabilities have been targeted with drugs focusing on cholinergic and glutamatergic transmission. These drugs increase the amount of acetylcholine present in the brain by increasing the production of acetylcholine precursors, as well as inhibiting acetylcholine degradation by cholinesterases. By focusing on heightening the activity of this system, the brain's responsiveness to activity-dependent plasticity is improved. Specifically, glutamatergic drugs may reduce the threshold for LTP, promote more normal dendritic spine morphology, and retain a greater number of useful synaptic connections. Cholinergic drugs may reconnect the basal forebrain with the cortex and hippocampus, connections that are often disrupted in patients with learning disorders.[8]

TOC Previous Next

Psychological factors

Psychological factors and preconceived notions about intelligence can be as influential on intelligence as genetic makeup. Children with early chronic stress show impaired corticolimbic connectivity in development. Early chronic stress is defined as inconsistent or inadequate care-giving and disruption to early rearing environment. These children showed decreased cognitive function, especially in fluid cognition, or the ability to effectively utilize working memory. The lack of connectivity between the limbic system and the prefrontal cortex can be blamed for this deficiency.[9]

TOC Previous Next

Behavioral factors

In the study of malleable intelligence, behavioral factors are often the most intriguing because these are factors humans can seek to control. There are numerous behavioral factors that affect intellectual development and neural plasticity. The key is plasticity, which is caused by experience-driven electrical activation of neurons. This experience-driven activation causes axons to sprout new branches and develop new presynaptic terminals.[2] These new branches often lead to greater mental processing in different areas.

TOC Previous Next

Taking advantage of the critical period

As previously discussed, the critical period is a time of neural pruning and great intellectual development.[2]

TOC Previous Next

See also

- Cognitive development
- Intelligence
- Intelligence quotient
- Neuroplasticity
- Improving fluid intelligence

References

1. ^ a b c d Garlick, D. (2002). Understanding the nature of the general factor of intelligence: The role of individual differences in neural plasticity as an explanatory mechanism. [Review]. Psychological Review, 109(1), 116–136.
2. ^ a b c d e f g Linden, D. J. (2007). The Accidental Mind: How Brain Evolution Has Given Us Love, Memory, Dreams, and God. Cambridge: The Belknap Press of Harvard University Press.
3. ^ a b Deary, I. J., Penke, L., & Johnson, W. (2010). The neuroscience of human intelligence differences. [Review]. Nature Reviews Neuroscience, 11(3), 201–211.
4. ^ Purves, D., Augustine, G., Fitzpatrick, D., Hall, W., LaMantia, A., McNamara, J., et al. (2008). Neuroscience (4th ed.). Sunderland, MA: Sinauer Associates, Inc.
5. ^ Gale, C. R., O'Callaghan, F. J., Godfrey, K. M., Law, C. M., & Martyn, C. N. (2004). Critical periods of brain growth and cognitive function in children. [Article]. Brain, 127, 321–329.
6. ^ *Malenka, R.C.; Nicoll, R.A. (1999). "Long-term potentiation – a decade of progress?". Science.* ***285*** *(5435): 1870–1874. doi:10.1126/science.285.5435.1870.*
7. ^ *Segal, M. (2005). "Dendritic spines and long-term plasticity". Nature Reviews. Neuroscience.* ***6****: 277–284. doi:10.1038/nrn1649.*
8. ^ Capone, G. T. (1998). Drugs that increase intelligence? Application for childhood cognitive impairment. [Proceedings Paper]. Mental Retardation and Developmental Disabilities Research Reviews, 4(1), 36–49.
9. ^ Blair, C. (2006). How similar are fluid cognition and general intelligence? A developmental neuroscience perspective on fluid cognition as an aspect of human cognitive ability. [Review]. Behavioral and Brain Sciences, 29(2), 109–160.

TOC Previous

External links

- The Entity Theory of Intelligence – *Parenting Science*
- Raising Our I.Q. – *NY Times*

Categories:

- Neuroscience
- Intelligence
- Cognitive science

This page was last edited on 5 February 2018, at 15:24.

Back to main TOC

Contents

Common coding Theory

Jump to navigation Jump to search

Common coding theory is a cognitive psychology theory describing how perceptual representations (e.g. of things we can see and hear) and motor representations (e.g. of hand actions) are linked. The theory claims that there is a shared representation (a common code) for both perception and action. More important, seeing an event activates the action associated with that event, and performing an action activates the associated perceptual event.[1]

The idea of direct perception-action links originates in the work of the American psychologist William James and more recently, American neurophysiologist and Nobel prize winner Roger Sperry. Sperry argued that the perception–action cycle is the fundamental logic of the nervous system.[2] Perception and action processes are functionally intertwined: perception is a means to action and action is a means to perception. Indeed, the vertebrate brain has evolved for governing motor activity with the basic function to transform sensory patterns into patterns of motor coordination.

Background

The classical approach to cognition is a 'sandwich' model which assumes three stages of information processing: perception, cognition and then action. In this model, perception and action do not interact directly, instead cognitive processing is needed to convert perceptual representations into action. For example, this might require creating arbitrary linkages (mapping between sensory and motor codes).[3]

In contrast, the common coding account claims that perception and action are directly linked by a common computational code.[4]

This theory, put forward by German scientist Wolfgang Prinz and his colleagues from the Max Planck Institute for Human Cognitive and Brain Sciences, claims parity between perception and action. Its core assumption is that actions are coded in terms of the perceivable effects (i.e., the distal perceptual events) they should generate.[5] This theory also states that perception of an action should activate action representations to the degree that the perceived and the represented action are similar.[6] Such a claim suggests that we represent observed, executed and imagined actions in a commensurate manner and makes specific predictions regarding the nature of action and perceptual representations. First, representations for observed and executed actions should rely on a shared neural substrate. Second, a common cognitive system predicts facilitation of action based on directly prior perception and vice versa. Third, such a system predicts interference effects when action and perception attempt to access shared representations simultaneously.

Evidence for common coding

In the past decade, a growing number of results have been interpreted in favor of the common coding theory.

For instance, one functional MRI study demonstrated that the brain's response to the 2/3 power law of motion (i.e., which dictates a strong coupling between movement curvature and velocity) is much stronger and more widespread than to other types of motion. Compliance with this law was reflected in the activation of a large network of brain areas subserving motor production, visual motion processing, and action observation functions. These results support the common coding and the notion of similar neural coding for motion perception and production.[7]

One of the most direct evidence for common coding in the brain now stems from the fact that pattern classifiers that can differentiate based on brain activity whether someone has performed action A or B can also classify, above chance, whether that person heard the sound of action A or B, thereby demonstrating that action execution and perception are represented using a common code.[8] Further support originates in EEG studies investigating the physiological substrate of perception and action in cognitive tasks. Segregating cortical activity by an independent component analysis (ICA) consistently reveals component relating to the processing of sensory stimuli and simultaneously to generating appropriate motor responses. This provides evidence for a common code involved in the whole perception-action loop.[9]

Recently, the common coding theory received increased interest from researchers in developmental psychology,[10] cognitive neuroscience,[11] robotics,[12] and social psychology.[13]

TOC Previous Next

Commensurate representation

Common coding posits, on top of separate coding, further domains of representation in which afferent and efferent information share the same format and dimensionality of representation. Common coding refers to 'late' afferent representations (referring to events in the environment) and 'early' efferent representations (referring to intended events). Such representations are commensurate since they both exhibit distal reference.[14][15] They permit creating linkages between perception and action that do not rely on arbitrary mappings. Common coding conceives action planning in terms of operations that determine intended future events from given current events (matching between event codes and action codes). In particular perception and action may modulate each other by virtue of similarity. Unlike rule-based mapping of incommensurate codes which requires preceding acquisition of mapping rules, similarity-based matching of commensurate codes requires no such preceding rule acquisition.

Ideomotor principle

In line with the ideomotor theory of William James (1890) and Hermann Lotze (1852), the common coding theory posits that actions are represented in terms of their perceptual consequences. Actions are represented like any other events, the sole distinctive feature being that they are (or can be) generated through bodily movements. Perceivable action consequences may vary on two major dimensions: resident vs. remote effects, and 'cool' versus 'hot' outcomes (i.e., reward values associated with action outcomes).[16]

When individuals perform actions they learn what their movements lead to (Ideomotor learning). The ideomotor theory claims that these associations can also be used in the reverse order (cf. William James, 1890 II, p. 526): When individuals perceive events of which they know (from previous learning) that they may result from certain movements, perception of these events may evoke the movements leading to them (Ideomotor control). The distinction between learning and control is equivalent to the distinction between forward and inverse computation in motor learning and control.[17] Ideomotor learning supports prediction and anticipation of action outcomes, given current action. Ideomotor control supports selection and control of action, given intended outcomes.

TOC Previous Next

Related approaches

While most traditional approaches tend to stress the relative independence of perception and action, some theories have argued for closer links. Motor theories of speech and action perception have made a case for motor contributions to perception.[18][19] Close non-representational connections between perception and action have also been claimed by ecological approaches.[20][21] Today common coding theory is closely related to research and theory in two intersecting fields of study: Mirror neurons systems and embodied cognition. As concerns mirror systems, common coding seems to reflect the functional logic of mirror neurons and mechanisms in the brain.[22] As concerns embodied cognition, common coding is compatible with the claim that meaning is embodied, i.e. grounded in perception and action.[23][24]

TOC Previous Next

See also

- Affective neuroscience
- Empathy
- Mental practice of action
- Motor cognition
- Motor imagery
- Neuroscience
- Social cognition

References

1. ^ Prinz, W. (1984). Modes of linkage between perception and action. In W. Prinz & A.-F. Sanders (Eds.), Cognition and motor processes (pp. 185-193). Berlin: Springer.
2. ^ *Sperry, R.W. (1952). "Neurology and the mind-body problem". American Scientist. **40**: 291–312.*
3. ^ Massaro, D. W. (1990). An information-processing analysis of perception and action. In O. Neumann & W. Prinz (Eds.), Relationships between perception and action: Current approaches (pp. 133-166). Berlin: Springer.
4. ^ Prinz, W. (2005). Experimental approaches to action. In J. Roessler and N. Eilan (Eds.), Agency and self-awareness (pp. 165-187). New-York, Oxford University press.
5. ^ *Prinz, W (1997). "Perception and action planning". European Journal of Cognitive Psychology. **9**: 129–154. doi:10.1080/713752551.*
6. ^ *Knoblich, G.; Flach, R. (2001). "Predicting the effects of actions: interactions of perception and action". Psychological Science. **12**: 467–472. doi:10.1111/1467-9280.00387.*
7. ^ *Eran Dayan, E.; Casile, A.; Levit-Binnun, N.; Giese, M.A.; Hendler, T.; Flash, T. (2007). "Neural representations of kinematic laws of motion: Evidence for action-perception coupling". PNAS. **104**: 20582–20587. doi:10.1073/pnas.0710033104. PMC 2154474 . PMID 18079289.*
8. ^ *Etzel, J. A.; Gazzola, V.; Keysers, C. (2008). "Testing Simulation Theory with Cross-Modal Multivariate Classification of fMRI Data". PLoS ONE. **3** (11): e3690. doi:10.1371/journal.pone.0003690. PMC 2577733 . PMID 18997869.*
9. ^ *Melnik, A; Hairston, WD; Ferris, DP; König, P (2017). "EEG correlates of sensorimotor processing: independent components involved in sensory and motor processing". Sci Rep. **7**: 4461. doi:10.1038/s41598-017-04757-8. PMC 5493645 . PMID 28667328.*
10. ^ *Sommerville, J. A.; Decety, J. (2006). "Weaving the fabric of social interaction: Articulating developmental psychology and cognitive neuroscience in the domain of motor cognition". Psychonomic*

Bulletin & Review. ***13***: *179–200. doi:10.3758/bf03193831. PMID 16892982.*
11. ^ *Jackson, P.L.; Decety, J. (2004). "Motor cognition: A new paradigm to investigate social interactions". Current Opinion in Neurobiology*. ***14***: *1–5. doi:10.1016/j.conb.2004.01.020.*
12. ^ Proctor and Vu (2006). Stimulus-response compatibility: Data, theory and application. Taylor & Francis
13. ^ *Dijksterhuis, A.; Bargh, J.A. (2001). "The perception-behavior expressway: automatic effects of social perception on social behavior". Advances in Experimental Social Psychology*. ***33***: *1–40.*
14. ^ *Prinz, W (1992). "Why don't we perceive our brain states?". European Journal of Cognitive Psychology*. ***4***: *1–20. doi:10.1080/09541449208406240.*
15. ^ *Hommel, B.; Müsseler, J.; Aschersleben, G.; Prinz, W. (2001). "The theory of event coding (TEC): A framework for perception and action planning". Behavioral and Brain Sciences.* ***24***: *849–878. doi:10.1017/s0140525x01000103. PMID 12239891.*
16. ^ Dickinson, A., & Balleine, B. W. (2002). The role of learning in the operation of motivational systems. In H. Pashler & R. Gallistel (Eds.), Stevens' handbook of experimental psychology (Vol. 3, pp. 497-533). New York: John Wiley.
17. ^ Wolpert, D., & Ghahramani, Z. (2004). Computational motor control. In M. S. Gazzaniga (Ed.), The cognitive neurosciences (3 ed., pp. 485-494). Cambridge, MA: MIT Press.
18. ^ Viviani, P. (2002). Motor competence in the perception of dynamic events: A tutorial. In W. Prinz & B. Hommel (Eds.), Common mechanisms in perception and action: Attention and Performance (Vol. XIX, pp. 406-442). Oxford: Oxford University Press.
19. ^ *Liberman, A. M. (1982). "On finding that speech is special". American Psychologist.* ***37***: *148–167. doi:10.1037/0003-066x.37.2.148.*
20. ^ Fowler, C. A., & Turvey, M. T. (1982). Observational perspective and descriptive level in perceiving and acting. In W. B. Weimer & D. S. Palermo (Eds.), Cognition and the symbolic processes (Vol. 2, pp. 1-19). Hillsdale, NJ: Lawrence Erlbaum.
21. ^ Gibson, J. J. (1979). The ecological approach to visual perception. Boston: Houghton Mifflin.

22. ^ *Rizzolatti, G.; Craighero, L. (2004). "The mirror-neuron system". Annual Review of Neuroscience. **27**: 169–192. doi:10.1146/annurev.neuro.27.070203.144230. PMID 15217330.*
23. ^ Noë, A. (2004) Action in Perception. MIT Press.
24. ^ *Barsalou, L. W. (2008). "Grounded cognition". Annual Review of Psychology. **59**: 617–645. doi:10.1146/annurev.psych.59.103006.093639.*

TOC Previous

Further reading

- *Morsella, E.; Bargh, J.A.; Gollwitzer, P.M., eds. (2009). Oxford Handbook of Human Action. New York: Oxford University Press. ISBN 978-0195309980.*
- *Roessler, J.; Eilan, N., eds. (2003). Agency and self-awareness. New York: Oxford University Press. ISBN 978-0199245628.*

Categories:

- Cognitive psychology
- Neuroscience
- Cognitive science
- Enactive cognition
- Action (philosophy)
- Motor control
- Motor cognition

Back to main TOC

Contents

Decision field Theory

Jump to navigation Jump to search

Decision field theory (**DFT**) is a dynamic-cognitive approach to human decision making. It is a cognitive model that describes how people actually make decisions rather than a rational or normative theory that prescribes what people should or ought to do. It is also a dynamic model of decision making rather than a static model, because it describes how a person's preferences evolve across time until a decision is reached rather than assuming a fixed state of preference. The preference evolution process is mathematically represented as a stochastic process called a diffusion process. It is used to predict how humans make decisions under uncertainty, how decisions change under time pressure, and how choice context changes preferences. This model can be used to predict not only the choices that are made but also decision or response times.

The paper "Decision Field Theory" was published by Jerome R. Busemeyer and James T. Townsend in 1993.[1][2][3][4] The DFT has been shown to account for many puzzling findings regarding human choice behavior including violations of stochastic dominance, violations of strong stochastic transitivity, violations of independence between alternatives, serial position effects on preference, speed accuracy tradeoff effects, inverse relation between probability and decision time, changes in decisions under time pressure, as well as preference reversals between choices and prices. The DFT also offers a bridge to neuroscience.[5] Recently, the authors of decision field theory also have begun exploring a new theoretical direction called Quantum Cognition.

TOP

TOC Next

Introduction

The name *decision field theory* was chosen to reflect the fact that the inspiration for this theory comes from an earlier approach - avoidance conflict model contained in Kurt Lewin's general psychological theory, which he called *field* theory. DFT is a member of a general class of sequential sampling models that are commonly used in a variety of fields in cognition.[6][7][8][9][10][11][12]

The basic ideas underlying the decision process for sequential sampling models is illustrated in Figure 1 below. Suppose the decision maker is initially presented with a choice between three risky prospects, A, B, C, at time t = 0. The horizontal axis on the figure represents deliberation time (in seconds), and the vertical axis represents preference strength. Each trajectory in the figure represents the preference state for one of the risky prospects at each moment in time.[4]

Intuitively, at each moment in time, the decision maker thinks about various payoffs of each prospect, which produces an affective reaction, or valence, to each prospect. These valences are integrated across time to produce the preference state at each moment. In this example, during the early stages of processing (between 200 and 300 ms), attention is focused on advantages favoring prospect C, but later (after 600 ms) attention is shifted toward advantages favoring prospect A. The stopping rule for this process is controlled by a threshold (which is set equal to 1.0 in this example): the first prospect to reach the top threshold is accepted, which in this case is prospect A after about two seconds. Choice probability is determined by the first option to win the race and cross the upper threshold, and decision time is equal to the deliberation time required by one of the prospects to reach this threshold.[4]

The threshold is an important parameter for controlling speed–accuracy tradeoffs. If the threshold is set to a lower value (about .30) in Figure 1, then prospect C would be chosen instead of prospect A (and done so earlier). Thus decisions can reverse under time pressure.[13] High thresholds require a strong preference state to be reached, which allows

more information about the prospects to be sampled, prolonging the deliberation process, and increasing accuracy. Low thresholds allow a weak preference state to determine the decision, which cuts off sampling information about the prospects, shortening the deliberation process, and decreasing accuracy. Under high time pressure, decision makers must choose a low threshold; but under low time pressure, a higher threshold can be used to increase accuracy. Very careful and deliberative decision makers tend to use a high threshold, and impulsive and careless decision makers use a low threshold.[4] To provide a bit more formal description of the theory, assume that the decision maker has a choice among three actions, and also suppose for simplicity that there are only four possible final outcomes. Thus each action is defined by a probability distribution across these four outcomes. The affective values produced by each payoff are represented by the values m_j. At any moment in time, the decision maker anticipates the payoff of each action, which produces a momentary evaluation, $U_i(t)$, for action i. This momentary evaluation is an attention-weighted average of the affective evaluation of each payoff: $U_i(t) = \Sigma W_{ij}(t)m_j$. The attention weight at time t, $W_{ij}(t)$, for payoff j offered by action i, is assumed to fluctuate according to a stationary stochastic process. This reflects the idea that attention is shifting from moment to moment, causing changes in the anticipated payoff of each action across time. The momentary evaluation of each action is compared with other actions to form a valence for each action at each moment, $v_i(t) = U_i(t) – U.(t)$, where U.(t) equals the average across all the momentary actions. The valence represents the momentary advantage or disadvantage of each action. The total valence balances out to zero so that all the options cannot become attractive simultaneously. Finally, the valences are the inputs to a dynamic system that integrates the valences over time to generate the output preference states. The output preference state for action i at time t is symbolized as $P_i(t)$. The dynamic system is described by the following linear stochastic difference equation for a small time step h in the deliberation process: $P_i(t+h) = \Sigma s_{ij}P_j(t)+v_i(t+h)$.The positive self feedback coefficient, $s_{ii} = s > 0$, controls the memory for past input valences for a preference state. Values of $s_{ii} < 1$ suggest decay in the memory or impact of previous valences over time, whereas values of $s_{ii} > 1$ suggest growth in

impact over time (primacy effects). The negative lateral feedback coefficients, $s_{ij} = s_{ji} < 0$ for i not equal to j, produce competition among actions so that the strong inhibit the weak. In other words, as preference for one action grows stronger, then this moderates the preference for other actions. The magnitudes of the lateral inhibitory coefficients are assumed to be an increasing function of the similarity between choice options. These lateral inhibitory coefficients are important for explaining context effects on preference described later. Formally, this is a Markov process; matrix formulas have been mathematically derived for computing the choice probabilities and distribution of choice response times.[4]

The decision field theory can also be seen as a dynamic and stochastic random walk theory of decision making, presented as a model positioned between lower-level neural activation patterns and more complex notions of decision making found in psychology and economics.[4]

Explaining context effects

The DFT is capable of explaining context effects that many decision making theories are unable to explain.[14]

Many classic probabilistic models of choice satisfy two rational types of choice principles. One principle is called independence of irrelevant alternatives, and according to this principle, if the probability of choosing option X is greater than option Y when only X,Y are available, then option X should remain more likely to be chosen over Y even when a new option Z is added to the choice set. In other words, adding an option should not change the preference relation between the original pair of options. A second principle is called regularity, and according to this principle, the probability of choosing option X from a set containing only X and Y should be greater than or equal to the probability of choosing option X from a larger set containing options X, Y, and a new option Z. In other words, adding an option should only decrease the probability of choosing one of the original pair of options. However, empirical findings obtained by consumer researchers studying human choice behavior have found systematic context effects that systematically violate both of these principles.

The first context effect is the similarity effect. This effect occurs with the introduction of a third option S that is similar to X but it is not dominated by X. For example, suppose X is a BMW, Y is a Ford focus, and S is an Audi. The Audi is similar to the BMW because both are not very economical but they are both high quality and sporty. The Ford focus is different from the BMW and Audi because it is more economical but lower quality. Suppose in a binary choice, X is chosen more frequently than Y. Next suppose a new choice set is formed by adding an option S that is similar to X. If X is similar to S, and both are very different from Y, the people tend to view X and S as one group and Y as another option. Thus the probability of Y remains the same whether S is presented as an option or not. However, the probability of X will decrease by approximately half with the introduction of S. This causes the probability of choosing X to drop below Y when S is added to the choice set. This violates the

independence of irrelevant alternatives property because in a binary choice, X is chosen more frequently than Y, but when S is added, then Y is chosen more frequently than X.

The second context effect is the compromise effect. This effect occurs when an option C is added that is a compromise between X and Y. For example, when choosing between C = Honda and X = BMW, the latter is less economical but higher quality. However, if another option Y = Ford Focus is added to the choice set, then C = Honda becomes a compromise between X = BMW and Y = Ford Focus. Suppose in a binary choice, X (BMW) is chosen more often than C (Honda). But when option Y (Ford Focus) is added to the choice set, then option C (Honda) becomes the compromise between X (BMW) and Y (Ford Focus), and C is then chosen more frequently than X. This is another violation of the independence of irrelevant alternatives property because X is chosen more often than C in a binary choice, but C when option Y is added to the choice set, then C is chosen more often than X.

The third effect is called the attraction effect. This effect occurs when the third option D is very similar to X but D is defective compared to X. For example D may be a new sporty car developed by a new manufacturer that is similar to option X = BMW, but costs more than the BMW. Therefore, there is little or no reason to choose D over X, and in this situation D is rarely ever chosen over X. However, adding D to a choice set boosts the probability of choosing X. In particular, the probability of choosing X from a set containing X,Y,D is larger than the probability of choosing X from a set containing only X and Y. The defective option D makes X shine, and this attraction effect violates the principle of regularity, which says that adding another option cannot increase the popularity of an option over the original subset.

DFT accounts for all three effects using the same principles and same parameters across all three findings. According to DFT, the attention switching mechanism is crucial for producing the similarity effect, but the lateral inhibitory connections are critical for explaining the compromise and attraction effects. If the attention switching process is eliminated, then the similarity effect disappears, and if the lateral connections are all set to

zero, then the attraction and compromise effects disappear. This property of the theory entails an interesting prediction about the effects of time pressure on preferences. The contrast effects produced by lateral inhibition require time to build up, which implies that the attraction and compromise effects should become larger under prolonged deliberation (see Roe et al.2001). Alternatively, if context effects are produced by switching from a weighted average rule under binary choice to a quick heuristic strategy for the triadic choice, then these effects should get larger under time pressure. Empirical tests show that prolonging the decision process increases the effects [15][16] and time pressure decreases the effects.[17]

Neuroscience

The Decision Field Theory has demonstrated an ability to account for a wide range of findings from behavioral decision making for which the purely algebraic and deterministic models often used in economics and psychology cannot account. Recent studies that record neural activations in non-human primates during perceptual decision making tasks have revealed that neural firing rates closely mimic the accumulation of preference theorized by behaviorally-derived diffusion models of decision making.[18]

The decision processes of sensory-motor decisions are beginning to be fairly well understood both at the behavioral and neural levels. Typical findings indicate that neural activation regarding stimulus movement information is accumulated across time up to a threshold, and a behavioral response is made as soon as the activation in the recorded area exceeds the threshold[19][20][21][22][23] for examples). A conclusion that one can draw is that the neural areas responsible for planning or carrying out certain actions are also responsible for deciding the action to carry out, a decidedly embodied notion.[18]

Mathematically, the spike activation pattern, as well as the choice and response time distributions, can be well described by what are known as diffusion models - especially in Two-alternative forced choice tasks(see Smith & Ratcliff[24] for a summary). Diffusion models, such as the decision field theory, can be viewed as stochastic recurrent neural network models, except that the dynamics are approximated by linear systems. The linear approximation is important for maintaining a mathematically tractable analysis of systems perturbed by noisy inputs. In addition to these neuroscience applications, diffusion models (or their discrete time, random walk, analogues) have been used by cognitive scientists to model performance in a variety of tasks ranging from sensory detection,[10] and perceptual discrimination,[8][9][11] to memory recognition,[12] and categorization.[6][7] Thus, diffusion models provide the potential to form a theoretical bridge between neural models of sensory-motor tasks and

behavioral models of complex-cognitive tasks.[18]

TOC Previous Next

Notes

1. ^ Busemeyer, J. R., & Townsend, J. T. (1993) Decision Field Theory: A dynamic cognition approach to decision making. Psychological Review, 100, 432–459.
2. ^ Busemeyer, J. R., & Diederich, A. (2002). Survey of decision field theory. Mathematical Social Sciences, 43(3), 345-370.
3. ^ Busemeyer, J. R., & Johnson, J. G. (2004). Computational models of decision making. Blackwell handbook of judgment and decision making, 133-154.
4. ^ *a* *b* *c* *d* *e* *f* Busemeyer, J. R., & Johnson, J. G. (2008). Microprocess models of decision making. Cambridge handbook of computational psychology, 302-321.
5. ^ Busemeyer, J. R., Jessup, R. K., Johnson, J. G., & Townsend, J. T. (2006). Building bridges between neural models and complex decision making behaviour. Neural Networks, 19(8), 1047-1058.
6. ^ *a* *b* Ashby, F. G. (2000). A stochastic version of general recognition theory. Journal of Mathematical Psychology, 44, 310–329.
7. ^ *a* *b* Nosofsky, R. M., & Palmeri, T. J. (1997). An exemplar-based random walk model of speeded classification. Psychological Review, 104, 226–300.
8. ^ *a* *b* Laming, D. R. (1968). Information theory of choice-reaction times. New York: Academic Press.
9. ^ *a* *b* Link, S. W., & Heath, R. A. (1975). A sequential theory of psychological discrimination. Psychometrika, 40, 77–111.
10. ^ *a* *b* Smith, P. L. (1995). Psychophysically principled models of visual simple reaction time. Psychological Review, 102(3), 567–593.
11. ^ *a* *b* Usher, M., & McClelland, J. L. (2001). The time course of perceptual choice: the leaky, competing accumulator model. Psychological Review, 108(3), 550–592.
12. ^ *a* *b* Ratcliff, R. (1978). A theory of memory retrieval. Psychological review, 85(2), 59.
13. ^ Diederich, A. (2003). MDFT account of decision making under time pressure. Psychonomic Bulletin and Review, 10(1), 157–166.
14. ^ Roe, R. M., Busemeyer, J. R., & Townsend, J. T. (2001). Multi-

alternative decision field theory: A dynamic connectionist model of decision-making. Psychological Review, 108, 370–392.
15. ^ Pettibone, J. C. (2012). Testing the effect of time pressure on asymmetric dominance and compromise decoys in choice. Judgment and Decision Making, 7(4), 513-523.
16. ^ Simonson, I. (1989). Choice based on reasons: The case of attraction and compromise effects. Journal of Consumer Research, 16, 158–174.
17. ^ Dhar, R., Nowlis, S. M., & Sherman, S. J. (2000). Trying hard or hardly trying: An analysis of context effects in choice. Journal of Consumer Psychology, 9, 189–200
18. ^ a b c Busemeyer, J. R., R. K. Jessup, Joseph G. Johnson, James T. Townsend. (2006). Building bridges between neural models and complex decision making behavior. Neural Networks 19(8): 1047-1058.
19. ^ Schall, J. D. (2003). Neural correlates of decision processes: neural and mental chronometry. Current Opinion in Neurobiology, 13(2), 182–186.
20. ^ Gold, J. I., & Shadlen, M. N. (2000). Representation of a perceptual decision in developing oculomotor commands. Nature, 404(6776), 390–394.
21. ^ Mazurek, M. E., Roitman, J. D., Ditterich, J., & Shadlen, M. N. (2003). A role for neural integrators in perceptual decision making. Cerebral Cortex, 13(11), 1257–1269.
22. ^ Ratcliff, R., Cherian, A., & Segraves, M. (2003). A comparison of macaque behavior and superior colliculus neuronal activity to predictions from models of two-choice decisions. Journal of Neurophysiology, 90(3), 1392–1407.
23. ^ Shadlen, M. N., & Newsome, W. T. (2001). Neural basis of a perceptual decision in the parietal cortex (area LIP) of the rhesus monkey. Journal of Neurophysiology, 86(4), 1916–1936.
24. ^ Smith, P. L., & Ratcliff, R. (2004). Psychology and neurobiology of simple decisions. Trends in Neurosciences, 27(3), 161–168.

References

- Busemeyer, J. R. & Diederich, A. (2002) Survey of decision field theory [1]. Mathematical Social Sciences, 43, 345–370.
- Busemeyer, J. R. & Johnson, J. J. (2004) Computational models of decision making. In D. Koehler & N. Harvey (Eds.) Handbook of Judgment and Decision Making. Blackwell Publishing Co. Ch. 7, Pp 133-154. [2]
- Busemeyer, J. R. & Johnson, J. J. (2008) Micro-process models of decision-making. In R. Sun (Ed.) Cambridge Handbook of Computational Cognitive Modeling. Cambridge University Press. [3]

Categories:

- Models of computation
- Decision theory
- Cognitive science
- Cognitive modeling
- Mathematical psychology

This page was last edited on 5 May 2017, at 17:11.

Back to main TOC

Protocol Analysis

Jump to navigation Jump to search

Protocol analysis is a psychological research method that elicits verbal reports from research participants. Protocol analysis is used to study thinking in cognitive psychology (Crutcher, 1994), cognitive science (Simon & Kaplan, 1989), and behavior analysis (Austin & Delaney, 1998). It has found further application in the design of surveys and interviews (Sudman, Bradburn & Schwarz, 1996), usability testing (Henderson, Smith, Podd, & Varela-Alvarez, 1995), educational psychology (Pressley & Afflerbach 1995; Renkl, 1997) and design research (Gero & McNeill 1998) .

See also

- Content analysis
- Partial concurrent thinking aloud
- Think aloud protocol

References

- Austin, J., & Delaney, P. F. (1998). Protocol analysis as a tool for behavior analysis. *Analysis of Verbal Behavior, 15,* 41-56.
- Crutcher, R. J. (1994). Telling what we know: The use of verbal report methodologies in psychological research. *Psychological Science, 5,* 241-244.
- Ericsson, K. A., & Crutcher, R. J. (1991). Introspection and verbal reports on cognitive processes - two approaches to the study of thought processes: A response to Howe. *New Ideas in Psychology, 9,* 57-71.
- Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data*. MIT Press, Cambridge, MA.
- Gero, J. S. & McNeill, T (1998) An approach to the analysis of design protocols, Design Studies 19(1): 21-61.
- Pressley, M., & Afflerbach, P. (1995). *Verbal protocols of reading: The nature of constructively responsive reading*. Hillsdale, NJ, USA: Erlbaum.
- Renkl, A. (1997). Learning from worked-out examples: A study on individual differences. *Cognitive Science, 21,* 1-29.
- Sudman, S., Bradburn, N. M., & Schwarz, N. (Eds.)(1996). *Thinking about answers: The application of cognitive processes to survey methodology.* San Francisco, CA, USA: Jossey-Bass.

External links

- protocol analysis
- [1]: A tool for facilitating verbal protocol analysis in English, German, Spanish, or Chinese.

TOP

Categories:

- Psychological methodology
- Cognitive science

This page was last edited on 7 February 2017, at 02:44.

Back to main TOC

Contents

Cognitive Archaeology

Jump to navigation Jump to search

Cognitive archaeology is a theoretical perspective in archaeology which focuses on the ways that ancient societies thought and the symbolic structures that can be perceived in past material culture.

Cognitive archaeologists often study the role that ideology and differing organizational approaches would have had on ancient peoples. The way that these abstract ideas are manifested through the remains that these peoples have left can be investigated and debated often by drawing inferences and using approaches developed in fields such as semiotics, psychology and the wider sciences.

Humans do not behave under the influence of their senses alone but also through their past experiences such as their upbringing. These experiences contribute to each individual's unique view of the world, a kind of cognitive map that guides them. Groups of people living together tend to develop a shared view of the world and similar cognitive maps which in turn influence their group material culture.

Archaeologists have always tried to imagine what motivated people but early efforts to understand how they thought were unstructured and speculative. Since the rise of processualism these approaches have become more scientific, paying close attention to the Archaeological context of archaeological finds and all possible interpretations. For example, a prehistoric bâton de commandement served an unknown purpose but using cognitive archaeology to interpret it would involve evaluating all its possible functions using clearly defined procedures and comparisons. By applying logic and experimental evidence, the most likely functions can be isolated.

The multiple interpretations of an artifact, archaeological site or symbol are affected by the archaeologist's own experiences and ideas as

well as those of the distant cultural tradition that created it. Cave art for example may not have been art in the modern sense at all but perhaps the product of ritual. Similarly, it would likely have described activities that were perfectly obvious to the people who created it but the symbology employed will be different from that used today or at any other time.

Some archaeologists such as Lewis Binford have critiqued cognitive archaeology, stating that it is only people's actions rather than their thoughts that are preserved in the archaeological record. However it can be argued that even this evidence of actions is still the product of human thought and would have been governed by a multitude of experiences and perspectives. Thus one can see Cognitive Archaeology as a development of Processual Archaeology in that the combination of material culture and actions can be further developed into a study of the ideas which drove action and used objects. This method attempts to avoid the pitfalls of Post-Processual Archaeology by retaining the 'scientific' aspects of Processual Archaeology while reaching for the higher social levels of ideas.

TOP

TOC Next

Examples

Archaeologist Thomas Huffman defines cognitive archaeology as the study of prehistoric ideology: the ideals, values, and beliefs that constitute a society's worldview. [2] Cognitive archaeologists use the principles of sociocultural anthropology to investigate such diverse things as material symbols, the use of space, political power, and religion. For example, Huffman uses oral history sources from Zimbabwe and Portuguese documents to attempt to explain symbols discovered in the ruins of Great Zimbabwe, specifically connecting the Shona people's historical association of the right with men and the left with women to the placement of entrances to stone structures. This cognitive archaeological approach may be problematic in its logical leaps and incomplete use of archaeological sources, as historian David Beach has pointed out, demonstrating the care that must be used when attempting to explain deep-time intentionality using archaeological evidence. [3]

See also

- Steven Mithen

TOC Previous Next

References

TOC Previous Next

Footnotes

1. ^ Burl 1981. p. 15.
2. ^ *Huffman, Thomas (1986). "Cognitive studies of the iron age in Southern Africa". World Archaeology. **18**: 84–95. doi:10.1080/00438243.1986.9979990.*
3. ^ *Beach, David (1998). "Cognitive Archaeology and Imaginary History at Great Zimbabwe". Current Anthropology. **39**: 47. doi:10.1086/204698.*

TOC Previous Next

Bibliography

- *Burl, Aubrey (1981). Rites of the Gods. London: Weidenfeld & Nicolson. ISBN 978-0460043137.*

TOC Previous

Further reading

- Cognitive Archaeology
- AURA Homepage of Cognitive Archaeology

Categories:

- Archaeological theory
- Cognitive science
- Anthropology

This page was last edited on 10 August 2017, at 07:16.

Back to main TOC

Contents

Augmented Learning

Jump to navigation Jump to search

Augmented learning is an on-demand learning technique where the environment adapts to the learner. By providing remediation on-demand, learners can gain greater understanding of a topic while stimulating discovery and learning.[1]

Technologies incorporating rich media and interaction have demonstrated the educational potential that scholars, teachers and students are embracing. Instead of focusing on memorization, the learner experiences an adaptive learning experience based upon the current context. The augmented content can be dynamically tailored to the learner's natural environment by displaying text, images, video or even playing audio (music or speech). This additional information is commonly shown in a pop-up window for computer-based environments.

Most implementations of augmented learning are forms of e-learning. In desktop computing environments, the learner receives supplemental, contextual information through an on-screen, pop-up window, toolbar or sidebar. As the user navigates a website, e-mail or document, the learner associates the supplemental information with the key text selected by a mouse, touch or other input device. In mobile environments, augmented learning has also been deployed on tablets and smartphones.

Augmented learning is closely related to augmented intelligence (intelligence amplification) and augmented reality. Augmented intelligence applies information processing capabilities to extend the processing capabilities of the human mind through distributed cognition. Augmented intelligence provides extra support for autonomous intelligence and has a long history of success. Mechanical and electronic devices that function as augmented intelligence range from the abacus, calculator, personal computers and smart phones. Software with augmented intelligence provide supplemental information that is related to

the context of the user. When an individual's name appears on the screen, a pop-up window could display person's organizational affiliation, contact information and most recent interactions.

In mobile reality systems,[2] the annotation may appear on the learner's individual "heads-up display" or through headphones for audio instruction. For example, apps for Google Glasses can provide video tutorials and interactive click-throughs, .[3]

Foreign language educators are also beginning to incorporate augmented learning techniques to traditional paper-and-pen-based exercises. For example, augmented information is presented near the primary subject matter, allowing the learner to learn how to write glyphs while understanding the meaning of the underlying characters. See Understanding language, below.

TOP

TOC Next

Just-in-time understanding and learning

Augmentation tools can help learners understand issues, acquire relevant information and solve complex issues by presenting supplementary information at the time of need or "on demand." This contrasts with traditional methods of associative learning, including rote learning, classical conditioning and observational learning, where the learning is performed in advance of the learner's need to recall or apply what has been learned.

Snyder and Wilson[4] assert that just-in-time learning is not sufficient. Long-term learning demands continuous training should be individualized and built upon individual competencies and strengths.

TOC Previous Next

Understanding language

Augmented learning tools have been useful for learners to gain an enhanced understanding of words or to understand a foreign language. The interactive, dynamic nature of these on-demand language assistants can provide definitions, sample sentences and even audible pronunciations. When sentences or blocks of text are selected, the words are read aloud while the user follows along with the native text or phonetics. Speech rate control can tailor the text-to-speech (TTS) to keep pace with the learner's comprehension.

TOC Previous Next

Making learning fun

One researcher[5] has suggested that handheld devices like cell phones and portable game machines (Game Boy, PlayStation Portable) can make an impact on learning. These mobile devices excel in their portability, context sensitivity, connectivity and ubiquity. By incorporating social dynamics in a real-world context, learning games can create compelling environments for learners.

At the Allard Pierson Museum in Amsterdam, visitors view information on-demand at the "A Future for the Past" exhibit. In a virtual reconstruction of Satricum and the Forum Romanum, users can call up information that is overlaid on room-sized photos and other images. The museum uses both stationary displays and mobile computers to allow users to view translucent images and information keyed to their specific interest. [6]

TOC | Previous | Next

Is augmentation really "learning"?

Critics may see learning augmentation as a crutch that precludes memorization; similar arguments have been made about using calculators in the past. Just as rote learning is also not a substitute for understanding, augmented learning is simply another faculty for helping learners recall, present and process information.

Current research suggests that even unconscious visual learning can be effective.[7] Visual stimuli, rendered in flashes of information, showed signs of learning even when the human adult subjects were unaware of the stimulus or reward contingencies.

TOC Previous Next

See also

- Intelligence amplification
- Learning
- Electronic learning
- Rote learning

References

1. ^ Augmented learning and super-adaptive learning
2. ^ Augmented Learning, Augmented Learning: Context-Aware Mobile Augmented Reality Architecture for Learning
3. ^ Augmented Reality Archived April 7, 2014, at the Wayback Machine.
4. ^ Computer Augmented Learning: The Basis of Sustained Knowledge Management Archived August 27, 2008, at the Wayback Machine.
5. ^ Klopfer, Eric Archived December 23, 2008, at the Wayback Machine., Augmented Learning: Research and Design of Mobile Educational Games
6. ^ Flatley, Joseph L., Augmented reality at the Allard Pierson Museum in Netherland
7. ^ *Seitz, Aaron R.; Kim, Dongho; Watanabe, Takeo (12 March 2009). "Rewards Evoke Learning of Unconsciously Processed Visual Stimuli in Adult Humans". Neuron.* ***61*** *(5): 700–707. doi:10.1016/j.neuron.2009.01.016.*

Sources

- Karacapilidis, Nikos (2009). Solutions and Innovations in Web-Based Technologies for Augmented Learning: Improved Platforms, Tools, and Applications. PA: IGI Global. ISBN 1-60566-238-0, ISBN 978-1-60566-238-1
- Milne, Andre J. (1999). Shaping the Future of Technology-Augmented Learning Environments: Report on a Planning Charrette at Stanford University. https://web.archive.org/web/20100708025551/http://www-cdr.stanford.edu/~amilne/Publish/SCUP-34_Abstract.PDF

TOC Previous

External links

- Loqu8 iCE Augmented learning software for understanding Chinese. Point or highlight Chinese text in webpages and documents. Displays definitions (in English, German and French), Pinyin and Bopomofo. Reads words aloud in Chinese (Mandarin, Cantonese).
- Augmented reality Augmented Reality Technology Brings Learning to Life

Categories:

- Learning
- Cognitive science
- Intelligence
- Systems science

This page was last edited on 24 August 2017, at 12:43.

Back to main TOC

Contents

Bongard Problem

A **Bongard problem** is a kind of puzzle invented by the Russian computer scientist Mikhail Moiseevich Bongard (Михаил Моисеевич Бонгард, 1924–1971), probably in the mid-1960s. They were published in his 1967 book on pattern recognition. Bongard, in the introduction of the book (which deals with a number of topics including perceptrons) credits the ideas in it to a group including M. N. Vaintsvaig, V. V. Maksimov, and M. S. Smirnov.

Overview

The idea of a Bongard problem is to present two sets of relatively simple diagrams, say *A* and *B*. All the diagrams from set *A* have a common factor or attribute, which is lacking in all the diagrams of set *B*. The problem is to find, or to formulate, convincingly, the common factor. The problems were popularised by their occurrence in the 1979 book *Gödel, Escher, Bach* by Douglas Hofstadter, himself a composer of Bongard problems. Bongard problems are also at the heart of the game Zendo.

Many computational architectures have been devised to solve Bongard problems, the most extensive of which being Phaeaco, by Harry Foundalis,[1] who left the field in 2008 due to ethical concerns regarding machines that can pass as human.[2]

TOC Previous Next

Scientific works on Bongard problems

- Bongard, M. M. (1970). Pattern Recognition. Rochelle Park, N.J.: Hayden Book Co., Spartan Books. (Original publication: Проблема Узнавания, Nauka Press, Moscow, 1967)
- Maksimov, V. V. (1975). Система, обучающаяся классификации геометрических изображений (A system capable of learning to classify geometric images; as translated from the Russian by Marina Eskina), in Моделирование Обучения и Поведения (Modeling of Learning and Behavior, in Russian), M.S. Smirnov, V.V. Maksimov (eds.), Nauka, Moskva.
- Hofstadter, D. R. (1979). Gödel, Escher, Bach: an Eternal Golden Braid. New York: Basic Books.
- Montalvo, F. S. (1985). Diagram Understanding: the Intersection of Computer Vision and Graphics. M.I.T. Artificial Intelligence Laboratory, A. I. Memo 873, November 1985.
- Saito, K., and Nakano, R. (1993) A Concept Learning Algorithm with Adaptive Search. Proceedings of Machine Intelligence 14 Workshop. Oxford University Press. See pp. 347–363.
- Hofstadter, D. R. and the Fluid Analogies Research Group (1995). Fluid Concepts and Creative Analogies: Computer Models of the Fundamental Mechanisms of Thought. New York: Basic Books.
- Hofstadter, D. R. (1995). On Seeing A's and Seeing As. Stanford Humanities Review 4/2 pp. 109–121.
- Hofstadter, D. R. (1997). Le Ton beau de Marot. New York: Basic Books.
- Linhares, A. (2000). A glimpse at the metaphysics of Bongard problems. Artificial Intelligence, Volume 121, Issue 1-2, pp. 251–270.
- Foundalis, H. (2006). Phaeaco: A Cognitive Architecture Inspired by Bongard's Problems. Doctoral dissertation, Indiana University, Center for Research on Concepts and Cognition (CRCC), Bloomington, Indiana.
- Anastasiade, J., and Szalwinski, C. (2010). Building Computer-Based Tutors to Help Learners Solve Ill-Structured Problems. In Proceedings of the World Conference on Educational Multimedia,

Hypermedia and Telecommunications 2010. Toronto, Ontario, Canada: Association for the Advancement of Computing in Education. pp. 3726–3732.

TOC Previous Next

References

1. ^ *Harry Foundalis. "The Bongard Problems". Retrieved 24 October 2013.*
2. ^ *Harry Foundalis. "Why I stopped working on the Bongard Problems". Retrieved 24 October 2013.*

External links

- Index of Bongard problems

Categories:

- Puzzles
- Machine learning
- Cognitive science
- Cognitive psychology
- Computer-related introductions in 1967

This page was last edited on 26 June 2017, at 22:17.

Back to main TOC

Cognitive Poetics

Jump to navigation Jump to search

Cognitive poetics is a school of literary criticism that applies the principles of cognitive science, particularly cognitive psychology, to the interpretation of literary texts. It has ties to reader-response criticism, and is also closely related to stylistics, whose application to literary study has been most popular in continental Europe. Like the New Critics, cognitive poetics engages in close analysis of the text, but it recognizes that context has an important role to play in the creation of meaning.

Due to its focus on how readers process the language of texts, cognitive poetics represents simultaneously a turn back in time, to the ancient study of rhetoric;[1] but it also has a grounding in modern principles of cognitive linguistics.

Topics addressed by cognitive poetics include deixis; text world theory (the feeling of immersion within texts); schema, script, and their role in reading; attention; foregrounding; and genre.

One of the main focal points of cognitive literary analysis is conceptual metaphor, an idea pioneered and popularized by the works of Lakoff, as a tool for examining texts. Rather than regarding metaphors as ornamental figures of speech, cognitive poetics examines how the conceptual bases of such metaphors interact with the text as a whole.

Prominent figures in the field include Reuven Tsur, who is credited for originating the term,[2] Ronald Langacker, Mark Turner and Peter Stockwell. Although Tsur's original, "precise and particular" sense of the term *poetics* was related to his theory of " poetry and perception", it has come to be "more broadly applied" to any "theory" or "system" of the workings (Greek *poiesis*) of literature of any genre.[1]

See also

- Cognitive philology
- Cognitive rhetoric
- Critical theory
- Literary theory

References

1. ^ a b "Cognitive poetics is still relatively new as a discipline, though it makes clear reconnections back to much older forms of analysis such as classical rhetoric." Stockwell (2002): p. 8.
2. ^ "Reuven Tsur ... has run a cognitive poetics project since the early 1970s, long before the first publications in cognitive linguistics." Gerard Steen and Joanna Gavins, "Contextualising cognitive poetics", in Gavins and Steen (2003): p. 3.

Bibliography

- Bachelard, Gaston (1960). *La poétique de la rêverie*. Paris: Presses Universitaires de France.
- Brône, Geert and Jeroen Vandaele (2009). *Cognitive Poetics. Goals, Gains and Gaps*. Berlin: Mouton de Gruyter
- Gavins, Joanna and Gerard Steen (2003). *Cognitive Poetics in Practice*. London: Routledge.
- Semino, Elena and Jonathan Culpeper (2002). *Cognitive Stylistics: Language and Cognition in Text Analysis*. Amsterdam and Philadelphia: John Benjamins.
- Stockwell, Peter (2002). *Cognitive Poetics: An Introduction*. London: Routledge.
- Tsur, Reuven (2008). *Toward a Theory of Cognitive Poetics*, Second, expanded and updated edition. Brighton and Portland: Sussex Academic Press.

TOP

Categories:

- Cognitive psychology
- Cognitive science
- Literary criticism

This page was last edited on 22 September 2016, at 00:31.

Contents

Embodied embedded Cognition

Jump to navigation Jump to search
See also: Enactivism, Embodied cognition, and Extended cognition

Embodied embedded cognition (**EEC**) is a philosophical theoretical position in cognitive science, closely related to situated cognition, embodied cognition, embodied cognitive science and dynamical systems theory. The theory states that intelligent behaviour emerges from the interplay between brain, body and world[1]. The world is not just the 'play-ground' on which the brain is acting. Rather, brain, body and world are equally important factors in the explanation of how particular intelligent behaviours come about in practice. There are concerns about whether EEC constitutes a novel and substantive approach to cognition or whether it is merely a manifestation of frustration with the classical cognitivist approach.

TOP

TOC Next

Embodiment and embeddedness

EEC is divided into two aspects: embodiment and embeddedness (or situatedness).

Embodiment refers to the idea that the body's internal milieu (a.o. homeostatic and hormonal states) heavily influences the higher 'cognitive' processes in the brain, presumably via the emotional system (see e.g. Antonio Damasio's theory of somatic markers). To put it simply: the state of your body is a direct factor of importance on the kinds of cognitive processes that may arise in the higher parts of your brain.

Embeddedness refers to the idea that physical interaction between the body and the world strongly constrain the possible behaviours of the organism, which in turn influences (indeed, partly constitutes) the cognitive processes that emerge from the interaction between organism and world.

The theory is an explicit reaction to the currently dominant cognitivist paradigm, which states that cognitive systems are essentially computational-representational systems (like computer software), processing input and generating output (behaviour) on the basis of internal information processing. In cognitivism, the causal root of behaviour lies in the 'virtual' processes governed by the software that runs on our brains. The brain is purely the hardware on which the software is implemented. The body (sensors and actors) are purely input-output devices that are in service of the brain. The world is merely the play-ground (the object) in which the cognitive agent acts.

In contrast, EEC holds that the actual physical processes in body and in body-world interaction partly constitute whatever it is that we call 'the cognitive system' as a whole. Body, world and brain form a system. Together these system-parts 'cause' intelligent behaviour to arise as a system property. Dynamical Systems Theory is a way of modeling behaviour that teams up quite naturally with the theoretical concepts of EEC.

Current discussions include:

- Is EEC really a (positive) theory of itself, or merely a bunch of complaints about what is wrong about (a too extreme version of) cognitivism?
- Is EEC too 'descriptive', instead of really explaining anything about cognition?
- How can EEC explain linguistic processes and processes of explicit conscious reasoning?
- What would be the most informative empirical hypotheses, starting from an EEC perspective?
- Can we use traditional methods (stimulus-response paradigms) of experimental psychology to test EEC hypotheses?

Theorists

Theorists that inspired the EEC programme (but might not necessarily adhere to the above position) include:

- Randall Beer
- Valentino Braitenberg
- Rodney Brooks
- William Clancey
- Andy Clark
- Paul Dourish
- Gerald Edelman
- Shaun Gallagher
- Pim Haselager
- Susan Hurley
- Fred Keijzer
- David Kirsh
- Alva Noë
- Mark Rowlands
- Humberto Maturana
- Maurice Merleau-Ponty
- Martin Heidegger
- Evan Thompson
- Jacob Von Uexküll
- Francisco Varela
- Tom Ziemke

See also

- Autopoesis
- Enactivism
- Extended cognition
- Neuroconstructivism
- Neurophenomenology
- Pragmatism
- Situated cognition

External links

- Some EEC links

TOC Previous

References

1. ^ *"Embodied Cognition". Stanford Encyclopedia. 25 July 2011.*

Categories:

- Cognitive science

This page was last edited on 14 May 2018, at 15:46.

Back to main TOC

Contents

Cognitive Geography

Cognitive geography is an interdisciplinary study of cognitive science and geography. It aims to understand how humans view space, place, and environment. It involves the formalization of factors that influence our spatial cognition to create a more effective representation of space. These improved models assist in a variety of issues, for example, the developing maps that communicate better, providing navigation instructions that are easier to follow, utilizing space more practically, accounting for the cultural differences on spatial thinking for more effective cross-cultural information exchange, and an overall increased understanding of our environment.

Notable researchers in this branch of geography include David Mark, Daniel Montello, Max J. Egenhofer, Andrew U Frank, Christian Freksa, Edward Tolman, and Barbara Tversky, among others.

Conference on Spatial Information Theory (COSIT) is a biennial international conference with a focus on the theoretical aspect of space and spatial information.

The US National Research Council published a book titled, “Learning to think spatially (2006)” written by the Committee on Support for Thinking Spatially. The committee believes that incorporating GIS and other spatial technologies in K-12 curriculum would promote spatial thinking and reasoning.

Origin and early works

The connection between spatial cognition and human activity and survival exists from ancient times. As learned from etymology, geometry has its origins in land surveying of the annual floods of the Nile river.[1] Spatial cognition developed from the study of cognitive psychology which began to be considered as a separate field in the late 1960s through Ulric Neisser's book *Cognitive Psychology* (1967).[1] Initially, research on spatial cognition was hindered due to many leading researchers believing that visual and spatial world could be explained using language processing.[1] Later on, research on imagery showed that by reducing the representation of the visual and spatial world into language researchers ignored 'fascinating' issues.[2][3] Around the same time, geographers were studying how people perceived and remembered the geographical world.[4]

Cognitive geography and behavioral geography draw from early behaviorist works such as Tolman's concepts of "cognitive maps". More cognitively oriented, these geographers focus on the cognitive processes underlying spatial reasoning, decision making, and behavior. More behaviorally oriented geographers are materialists and look at the role of basic learning processes and how they influence the landscape patterns or even group identity.[5]

Examples of early works on Cognitive Geography include Tolman's \`Cognitive maps in rats and men' compared the behavior of laboratory rats with the navigation and wayfinding abilities of humans. Similar work during that period dealt with the peoples' perception of direction and spatial relations, for example, Americans typically think that South America is aligned directly south of North America when in fact most of South America is much further east.[6] In the early 70s, the focus was on how to improve maps by providing useful information, delivering an understandable message, and making it more aesthetically pleasing.[1]

Research in cognitive geography

The interaction between humans and the environment is a major focus among the Geographers. The objective of this research area is to minimize the disparity between the environment and its geometric representation and the removal of spatial cognitive biases that are inherent. Examples of spatial cognitive biases include the overestimation of distance between two locations when there is a large number of intersections and nodes in the path. There is a tendency to recollect irregular streets or rivers as straighter, more parallel, or more perpendicular than they are. David Mark through his research illustrates how spatial features like inland water bodies (lakes, ponds, lagoons) are categorized differently in English and French speaking population, and therefore, could cause issues in cross-cultural geographical information exchange.

Studies have been done on wayfinding and navigation. Wayfinding is defined as “the mental processes involved in determining a route between two points and then following that route” and involves planning trips, optimizing routes, and exploring different places. The researchers are trying to find the perfect amount of information, not more and not less, for making navigation more efficient. Landmarks play an important factor in wayfinding and navigation, therefore, researchers are looking to automate the selection of landmarks which would make maps easier to follow.

Displaying information through maps has been shaped by how humans sense space and direction. Communicating effectively through maps is a challenge for many cartographers. For example, symbols, their color, and their relative size have an important role to play in the interaction between the map and the mapmaker.

The study of Geo-ontology has also been of interest to researchers in this field. Geo-ontology involves the study of the variations among different cultures in how they view and sense landforms, how to communicate spatial knowledge with other cultures while overcoming such barriers, an understanding of the cognitive aspects of spatial relations, and how to represent them in computational models.[7] For example, there might be

some geographic meaning that might not be well explained using words. There might be some differences in understanding when spatial information is explained verbally instead of non-verbal form.

Some of the questions that cognitive geographers deal with include the influence of scale on the information provided in maps, the difference in how we view geographic knowledge differently from different sources, for example, text-based, map-based, or any real-world experience. A typical study in Cognitive Geography involves volunteers responding to a questionnaire after being shown some spatial information. The researchers use this data to find the spectrum of interpretations by the volunteers about the subject in focus.[8][9]

See also

- Behavioral geography
- Cognitive psychology
- Spatial Cognition
- Geovisualization
- Wayfinding

TOC Previous Next

References

TOC Previous Next

Notes

1. ^ a b c d *Mark, David M.; Freksa, Christian; Hirtle, Stephen C.; Lloyd, Robert; Tversky, Barbara (1999-12-01). "Cognitive models of geographical space". International Journal of Geographical Information Science. **13** (8): 747–774. doi:10.1080/136588199241003. ISSN 1365-8816.*
2. ^ Kosslyn, Stephen Michael. *Image and mind*. Harvard University Press, 1980.
3. ^ *"Cognitive processes that resemble perceptual processes". APA PsycNET. 1978-01-01.*
4. ^ O'keefe, John, and Lynn Nadel. *The hippocampus as a cognitive map*. Oxford: Clarendon Press, 1978.
5. ^ Norton, W. (1997). Human geography and behavior analysis: An application of behavior analysis to the evolution of human landscapes. *The Psychological Record*, 47, 439–460
6. ^ *Tversky, Barbara (1981-07-01). "Distortions in memory for maps". Cognitive Psychology. **13** (3): 407–433. doi:10.1016/0010-0285(81)90016-5.*
7. ^ Mark, David M. "Spatial representation: a cognitive view." *Geographical information systems: Principles and applications* 1 (1999): 81-89.
8. ^ Montello, Daniel R. "Cognitive research in GIScience: Recent achievements and future prospects." *Geography Compass* 3.5 (2009): 1824-1840.
9. ^ Montello, Daniel R. "Cognitive geography." (2009).

TOC Previous Next

Further reading

- Downs, Roger M., and David Stea. (1977). *Maps in Minds: Reflections on Cognitive Mapping*. HarperCollins Publishers.

- Kitchin, Rob, and Scott Freundschuh, eds. (2000). *Cognitive Mapping: Past, Present, and Future.* Vol. 4. Psychology Press.
- Mark, David M., et al. (1999). "Cognitive models of geographical space." *International Journal of Geographical Information Science* 13.8: 747-774.
- Montello, Daniel R. (2009). "Cognitive geography." pp. 160–166 in *International Encyclopedia of Human Geography* 2.
- Montello, Daniel R., et al. (2003). "Testing the first law of cognitive geography on point-display spatializations." pp. 316–331 in *Spatial Information Theory. Foundations of Geographic Information Science.* Berlin/ Heidelberg: Springer.
- Portugali, Juval, ed. (1996). *The Construction of Cognitive Maps.* Vol. 32. Springer Science & Business Media.

External links

Categories:

- Human geography
- Cognitive science
- Environmental social science

This page was last edited on 18 December 2017, at 05:50.

Back to main TOC

Computational Semiotics

Jump to navigation Jump to search

Computational semiotics is an interdisciplinary field that applies, conducts, and draws on research in logic, mathematics, the theory and practice of computation, formal and natural language studies, the cognitive sciences generally, and semiotics proper. A common theme of this work is the adoption of a sign-theoretic perspective on issues of artificial intelligence and knowledge representation. Many of its applications lie in the field of human-computer interaction (HCI) and fundamental devices of recognition.

One part of this field, known as algebraic semiotics, combines aspects of algebraic specification and social semiotics, and has been applied to user interface design and to the representation of mathematical proofs.

Bibliography

- Andersen, P.B. (1991). *A Theory of Computer Semiotics*, Cambridge University Press.
- de Souza, C.S., *The Semiotic Engineering of Human-Computer Interaction*, MIT Press, Cambridge, MA, 2005.
- Tanaka-Ishii, K. (2010), "Semiotics of Programming", Cambridge University Press.
- Hugo, J. (2005), "The Semiotics of Control Room Situation Awareness", *Fourth International Cyberspace Conference on Ergonomics*, Virtual Conference, 15 Sep – 15 Oct 2005. Eprint
- Gudwin, R.; Queiroz J. (eds) - *Semiotics and Intelligent Systems Development* - Idea Group Publishing, Hershey PA, USA (2006), ISBN 1-59904-063-8 (hardcover), 1-59904-064-6 (softcover), 1-59904-065-4 (e-book), 352 ps. Link to publisher
- Gudwin, R.; Queiroz, J. - *Towards an Introduction to Computational Semiotics* - Proceedings of the 2005 IEEE International Conference on Integration of Knowledge Intensive Multi-Agent Systems - KIMAS'05, 18–21 April 2005, Waltham, MA, USA, pp. 393–398. IEEExplore
- Mili, A., Desharnais, J., Mili, F., with Frappier, M., *Computer Program Construction*, Oxford University Press, New York, NY, 1994. — Introduction to Tarskian relation theory and its applications within the relational programming paradigm.
- Rieger, Burghard B.: *Computing Granular Word Meanings. A fuzzy linguistic approach to Computational Semiotics*, in: Wang, Paul P. (ed.): Computing with Words. [Wiley Series on Intelligent Systems 3], New York (John Wiley & Sons) 2001, pp. 147–208.
- Rieger, Burghard B.: *Computing Fuzzy Semantic Granules from Natural Language Texts. A computational semiotics approach to understanding word meanings*, in: Hamza, M.H. (ed.): Artificial Intelligence and Soft Computing, Proceedings of the IASTED International Conference, Anaheim/ Calgary/ Zürich (IASTED/ Acta Press) 1999, pp. 475–479.
- Rieger, Burghard B.: *A Systems Theoretical View on Computational*

Semiotics. Modeling text understanding as meaning constitution by SCIPS, in: Proceedings of the Joint IEEE Conference on the Science and Technology of Intelligent Systems (ISIC/CIRA/ISAS-98), Piscataway, NJ (IEEE/Omnipress) 1998, pp. 840–845. IEEExplore

External links

- Goguen, J., Algebraic Semiotics
- Gudwin, R.R., Computational Semiotics
- Gudwin, R.R., List of Publications in Computational Semiotics and other fields
- International Computational Semiotics Group
- UNICAMP Computational Semiotics Group

TOP

Categories:

- Semiotics
- Theory of computation
- Cognitive science
- Computational fields of study

This page was last edited on 1 September 2017, at 02:00.

Back to main TOC

Contents

Semantic feature-comparison Model

Jump to navigation Jump to search

The **semantic feature comparison model** is used "to derive predictions about categorization times in a situation where a subject must rapidly decide whether a test item is a member of a particular target category".[1] In this semantic model, there is an assumption that certain occurrences are categorized using its features or attributes of the two subjects that represent the part and the group. A statement often used to explain this model is "a robin is a bird". The meaning of the words *robin* and *bird* are stored in the memory by virtue of a list of features which can be used to ultimately define their categories, although the extent of their association with a particular category varies.

TOP

TOC Next

History

This model was conceptualized by Edward Smith, Edward Shoben and Lance Rips in 1974 after they derived various observations from semantic verification experiments conducted at the time. Respondents merely have to answer "true" or "false" to given sentences. Out of these experiments, they observed that people respond faster when (1) statements are true, (2) nouns are members of smaller categories, (3) items are "typical" or commonly associated with the category (also called prototypes), and (4) items are primed by a similar item previously given (University of Alaska Anchorage, n.d.). In the latter item, respondents will respond faster to the latter statement since the category bird has been primed. Based on the previous observations, the proponents were able to come up with the semantic feature comparison model.[1]

TOC Previous Next

Theory

The cognitive approach consists of two concepts: information processing depends on internal representations, and that mental representations undergo transformations. For the first concept, we could describe an object in a number of ways, with drawings, equations, or verbal descriptions, but it is up to the recipient to have a background understanding of the context to which the object is being described in order to fully comprehend the deliverable. The second concept explains how memory can alter the way we perceive representations of something, by determining the sequence in which the information is processed based on previous experiences.

TOC Previous Next

Features

The main features of the model, as discussed by Smith et al. (1974), are the defining features and the characteristic features. Defining features refer to the characteristics that are essential elements of the category, the non-negotiable, so to speak. For example, the 'bird' category includes such defining features as 'they have wings', 'feathers', 'they lay eggs', etc. Characteristic features refer to the elements usually found or inherent to category members but are not found in all, or non-essentials. For example, birds 'fly', – that is characteristic because while most birds fly, there are some who cannot.

The model has two stages for decision making. First, all features of the two concepts (bird and robin, in our example) are compared to find out how alike they are. If the decision is that they are very similar or very dissimilar, then a true or false decision can be made. Second, if the characteristics/features are in-between then the focus shifts to the defining features in order to decide if the example possesses enough features of the category, thus, categorization depends on similarity and not on the size of the category.

TOC Previous

References

1. ^ a b Smith, E. E., Shoben. E. J., and Rips, L. J. (1974). Structure and Process in Semantic Memory: A Feature Model for Semantic Decisions. Psychological Review, 81(3), 214–241.

- University of Alaska Anchorage (n.d.). Cognitive Psychology – Memory Models, Knowledge Representation. Retrieved November 5, 2012 from http://www.math.uaa.alaska.edu/~afkjm/cs405/handouts/psycho.pdf
- Gazzaniga, Michael S., Richard B. Ivry, and G. R. Mangun. "Methods of Cognitive Neuroscience." Cognitive neuroscience: the biology of the mind. Third ed. New York: W.W. Norton, 1998. 111–112. Print.

Categories:

- Cognitive science

Back to main TOC

Contents

Artificial intelligence, situated Approach

Jump to navigation Jump to search

In artificial intelligence research, the **situated approach** builds agents that are designed to behave effectively successfully in their environment. This requires designing AI "from the bottom-up" by focussing on the basic perceptual and motor skills required to survive. The situated approach gives a much lower priority to abstract reasoning or problem-solving skills.

The approach was originally proposed as an alternative to traditional approaches (that is, approaches popular before 1985 or so). After several decades, classical AI technologies started to face intractable issues (e.g. combinatorial explosion) when confronted with real-world modeling problems. All approaches to address these issues focus on modeling intelligences situated in an environment. They have become known as the situated approach to AI.

Emergence of a concept

TOC Next

From traditional AI to Nouvelle AI

During the late 1980s, the approach now known as **Nouvelle AI** (*Nouvelle* means new in French) was pioneered at the MIT Artificial Intelligence Laboratory by Rodney Brooks. As opposed to classical or traditional artificial intelligence, Nouvelle AI purposely avoided the traditional goal of modeling human-level performance, but rather tries to create systems with intelligence at the level of insects, closer to real-world robots. But eventually, at least at MIT new AI did lead to an attempt for humanoid AI in the Cog Project.

TOC Previous Next

From Nouvelle AI to behavior-based and situated AI

The conceptual shift introduced by nouvelle AI flourished in the robotics area, given way to **behavior-based artificial intelligence** (BBAI), a methodology for developing AI based on a modular decomposition of intelligence. It was made famous by Rodney Brooks: his subsumption architecture was one of the earliest attempts to describe a mechanism for developing BBAI. It is extremely popular in robotics and to a lesser extent to implement intelligent virtual agents because it allows the successful creation of real-time dynamic systems that can run in complex environments. For example, it underlies the intelligence of the Sony, Aibo and many RoboCup robot teams.

Realizing that in fact all these approaches were aiming at building not an abstract intelligence, but rather an intelligence **situated** in a given environment, they have come to be known as the situated approach. In fact, this approach stems out from early insights of Alan Turing, describing the need to build machines equipped with sense organs to learn directly from the real-world instead of focusing on abstract activities, such as

playing chess.[*relevant?* – *discuss*]

Definitions

Classically, a software entity is defined as a simulated element, able to act on itself and on its environment, and which has an internal representation of itself and of the outside world. An entity can communicate with other entities, and its behavior is the consequence of its perceptions, its representations, and its interactions with the other entities.

AI loop

Simulating entities in a virtual environment requires simulating the entire process that goes from a perception of the environment, or more generally from a stimulus, to an action on the environment. This process is called the AI loop and technology used to simulate it can be subdivided in two categories. *Sensorimotor or low-level* AI deals with either the perception problem (what is perceived?) or the animation problem (how are actions executed?). *Decisional or high-level* AI deals with the action selection problem (what is the most appropriate action in response to a given perception, i.e. what is the most appropriate behavior?).

Traditional or symbolic AI

There are two main approaches in decisional AI. The vast majority of the technologies available on the market, such as planning algorithms, finite state machines (FSA), or expert systems, are based on the **traditional or symbolic** AI approach. Its main characteristics are:

- It is **top-down**: it subdivides, in a recursive manner, a given problem into a series of sub-problems that are supposedly easier to solve.
- It is **knowledge-based**: it relies on a symbolic description of the world, such as a set of rules.

However, the limits of traditional AI, which goal is to build systems that

mimic human intelligence, are well-known: inevitably, a combinatorial explosion of the number of rules occurs due to the complexity of the environment. In fact, it is impossible to predict all the situations that will be encountered by an autonomous entity.

TOC Previous Next

Situated or behavioral AI

In order to address these issues, another approach to decisional AI, also known as **situated or behavioral** AI, has been proposed. It does not attempt to model systems that produce deductive reasoning processes, but rather systems that **behave realistically in their environment**. The main characteristics of this approach are the following:

- It is **bottom-up**: it relies on elementary behaviors, which can be combined to implement more complex behaviors.
- It is **behavior-based**: it does not rely on a symbolic description of the environment, but rather on a model of the interactions of the entities with their environment.

The goal of situated AI is to model entities that are autonomous in their environment. This is achieved thanks to both the intrinsic robustness of the control architecture, and its adaptation capabilities to unforeseen situations.

TOC Previous Next

Situated agents

In artificial intelligence and cognitive science, the term **situated** refers to an agent which is embedded in an environment. The term *situated* is commonly used to refer to robots, but some researchers argue that software agents can also be situated if:

- they exist in a dynamic (rapidly changing) environment, which
- they can manipulate or change through their actions, and which
- they can sense or perceive.

Examples might include web-based agents, which can alter data or trigger processes (such as purchases) over the Internet, or virtual-reality bots which inhabit and change virtual worlds, such as Second Life.

Being situated is generally considered to be part of being embodied, but it is useful to consider each perspective individually. The situated perspective emphasizes that intelligent behavior derives from the environment and the agent's interactions with it. The nature of these interactions are defined by an agent's embodiment.

TOC Previous Next

Implementation principles

Modular decomposition

The most important attribute of a system driven by situated AI is that the intelligence is controlled by a set of independent semi- autonomous modules. In the original systems, each module was actually a separate device or was at least conceived of as running on its own processing thread. Generally, though, the modules are just abstractions. In this respect, situated AI may be seen as a software engineering approach to AI, perhaps akin to object oriented design.

Situated AI is often associated with reactive planning, but the two are not synonymous. Brooks advocated an extreme version of cognitive minimalism which required initially that the behavior modules were finite state machines and thus contained no conventional memory or learning. This is associated with reactive AI because reactive AI requires reacting to the current state of the world, not to an agent's memory or preconception of that world. However, learning is obviously key to realistic strong AI, so this constraint has been relaxed, though not entirely abandoned.

TOC Previous Next

Action selection mechanism

The situated AI community has presented several solutions to modeling decision-making processes, also known as action selection mechanisms. The first attempt to solve this problem goes back to *subsumption architectures*,[1] which were in fact more an implementation technique than an algorithm. However, this attempt paved the way to several others, in particular the *free-flow hierarchies*[2] and *activation networks*.[3] A comparison of the structure and performances of these two mechanisms demonstrated the advantage of using *free-flow hierarchies* in solving the

action selection problem.[4][5] However, *motor schemas*[6] and *process description languages*[7] are two other approaches that have been used with success for autonomous robots.

Notes and references

1. ^ Brooks, R. (1986). A robust layered control system for a mobile robot. IEEE Journal of Robotics and Automation 2(1):14-23.
2. ^ Rosenblatt J. and Payton D (1989). A fine-grained alternative to the subsumption architecture for mobile robot control. In: Proceedings of the IEEE International Conference on Neural Networks 2:317-324.
3. ^ Maes P. (1989). How to do the right thing. Technical Report AIM-1180, MIT Artificial Intelligence Laboratory.
4. ^ Tyrrell T. (1993). Computational mechanisms for action selection. PhD, University of Edinburgh.
5. ^ Tyrrell T (1993). The use of hierarchies for action selection. Adaptive Behavior 1(4):387-420.
6. ^ Arkin R. Motor schema based navigation for a mobile robot: an approach to programming by behavior. In: Proceedings of the IEEE Conference on Robotics and Automation, pp. 264-271, 1987.
7. ^ Steels, L. (1993). Building agents with autonomous behavior systems. In: The artificial route to artificial intelligence. Building situated embodied agents. Lawrence Erlbaum Associates, New Haven.

- Arsenio, Artur M. (2004) *Towards an embodied and situated AI*, In: Proceedings of the International FLAIRS conference, 2004. (online)
- *The Artificial Life Route To Artificial Intelligence: Building Embodied, Situated Agents*, Luc Steels and Rodney Brooks Eds., Lawrence Erlbaum Publishing, 1995. (ISBN 978-0805815184)
- Rodney A. Brooks *Cambrian Intelligence* (MIT Press, 1999) ISBN 0-262-52263-2; collection of early papers including "Intelligence without representation" and "Intelligence without reason", from 1986 & 1991 respectively.
- Ronald C. Arkin *Behavior-Based Robotics* (MIT Press, 1998) ISBN 0-262-01165-4
- Hendriks-Jansen, Horst (1996) *Catching Ourselves in the Act: Situated Activity, Interactive Emergence, Evolution, and Human*

Thought. Cambridge, Mass.: MIT Press.

TOC Previous Next

See also

TOC Previous Next

Related articles

- Artificial Intelligence
- Cognitive science

TOC Next

Traditional AI

- Decision Tree
- Finite State Machine
- Expert System
- Automated Planning and Scheduling

TOC Previous Next

Situated AI

- Scruffy AI
- Reactive planning

TOC Previous

Robotics

- Behavior-based robotics
- Situated robotics

TOC Previous

External links

- Article Artificial Intelligence: The situated approach from the Encyclopædia Britannica
- Article What is AI? - Nouvelle AI [*permanent dead link*] from AlanTuring.net
- Nouvelle AI - Definition
- Reactive planning and nouvelle AI

Categories:

- Artificial intelligence
- Cognitive science

This page was last edited on 28 April 2018, at 01:45.

Back to main TOC

Planning (cognitive)

Jump to navigation Jump to search

Cognitive planning is one of the executive functions. It encompasses the neurological processes involved in the formulation, evaluation and selection of a sequence of thoughts and actions to achieve a desired goal. Various studies utilizing a combination of neuropsychological, neuropharmacological and functional neuroimaging approaches have suggested there is a positive relationship between impaired planning ability and damage to the frontal lobe.

A specific area within the mid-dorsolateral frontal cortex located in the frontal lobe has been implicated as playing an intrinsic role in both cognitive planning and associated executive traits such as working memory.

Disruption of the neural pathways, via various mechanisms such as traumatic brain injury, or the effects of neurodegenerative diseases between this area of the frontal cortex and the basal ganglia specifically the striatum (cortico-striatal pathway), may disrupt the processes required for normal planning function.[1]

Individuals who were born with very low birth weight (VLBW - <1500 grams) and extremely low birth weight (ELBW) are at greater risk of various cognitive deficits including planning ability.[2]

Neuropsychological tests

There are a variety of neuropsychological tests which can be used to measure variance of planning ability between the subject and controls.

- **Tower of Hanoi** (TOH-R), a puzzle invented in 1883 by the French mathematician Édouard Lucas. There are variations of the puzzle - the classic version consists of three rods and usually seven to nine discs of subsequently smaller size. Planning is a key component of the problem solving skills necessary to achieve the objective, which is to move the entire stack to another rod, obeying the following rules:
    - Only one disk may be moved at a time.
    - Each move consists of taking the upper disk from one of the rods and sliding it onto another rod, on top of the other disks that may already be present on that rod.
    - No disk may be placed on top of a smaller disk.[3]

- **Tower of London** (TOL) is another test that was developed in 1982 (Shallice 1982) specifically to detect deficits in planning as may occur with damage to the frontal lobe. test participants with damage to the left anterior frontal lobe demonstrated planning deficits (i.e., greater number of moves required for solution).

In test, participants with damage to the right anterior, and left or right posterior areas of the frontal lobes showed no impairment. The results implicating the left anterior frontal lobes involvement in solving the TOL were supported in concomitant neuroimaging studies which also showed a reduction in regional cerebral blood flow to the left pre-frontal lobe. For the number of moves, a significant negative correlation was observed for the left prefrontal area, i.e. subjects that took more time planning their moves showed greater activation in the left prefrontal area.[4]

References

1. ^ *"Cognitive planning in humans: neuropsychological, neuroanatomical and neuropharmacological perspectives". Prog. Neurobiol.* ***53*** *(4): 431–50. November 1997. doi:10.1016/s0301-0082(97)00042-7. PMID 9421831.*
2. ^ *Harvey, JM; O'Callaghan, MJ; Mohay, H (May 1999). "Executive function of children with extremely low birthweight: a case control study". Dev Med Child Neurol.* ***41*** *(5): 292–7. doi:10.1017/s0012162299000663. PMID 10378753.*
   - Aarnoudse-Moens, CS; Weisglas-Kuperus, N; van Goudoever, JB; Oosterlaan, J (August 2009). "Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children". Pediatrics. ***124*** *(2): 717–28. doi:10.1542/peds.2008-2816. PMID 19651588.*
3. ^ *Welsh, MC; Huizinga, M (June 2001). "The development and preliminary validation of the Tower of Hanoi-revised". Assessment.* ***8*** *(2): 167–76. doi:10.1177/107319110100800205. PMID 11428696.*
   - Anderson, JR; Albert, MV; Fincham, JM (August 2005). "Tracing problem solving in real time: fMRI analysis of the subject-paced Tower of Hanoi". J Cogn Neurosci. ***17*** *(8): 1261–74. doi:10.1162/0898929055002427. PMID 16197682.*
4. ^ *Shallice, T. (1982). "Specific impairments of planning". Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences.* ***298*** *(1089): 199–209. doi:10.1098/rstb.1982.0082. PMID 6125971.*

Bibliography

J P Das, Binod C Kar, Rauno K Parrila, *Cognitive Planning: The Psychological Basis of Intelligent Behaviour*. Sage Publications Pvt. Ltd; illustrated edition. ISBN 0-8039-9287-4 ISBN 978-0-8039-9287-0

TOP

Categories:

- Cognition
- Neuropsychology
- Neuropsychological assessment
- Cognitive science
- Attention deficit hyperactivity disorder
- Motor control

This page was last edited on 25 June 2017, at 21:58.

Contents

Primary Consciousness

Jump to navigation Jump to search

Primary consciousness is a term the American biologist Gerald Edelman coined to describe the ability, found in humans and some animals, to integrate observed events with memory to create an awareness of the present and immediate past of the world around them. This form of consciousness is also sometimes called "sensory consciousness". Put another way, primary consciousness is the presence of various subjective sensory contents of consciousness such as sensations, perceptions, and mental images. For example, primary consciousness includes a person's experience of the blueness of the ocean, a bird's song, and the feeling of pain. Thus, primary consciousness refers to being mentally aware of things in the world in the present without any sense of past and future; it is composed of mental images bound to a time around the measurable present.[1]

Conversely, higher order consciousness can be described as being "conscious of being conscious"; it includes reflective thought, a concept of the past, and speculation about the future.

Primary consciousness can be subdivided into two forms, focal awareness and peripheral awareness. Focal awareness encompasses the center of attention, whereas peripheral awareness consists of things outside the center of attention, which a person or animal is only dimly aware of.[2]

Theories

One prominent theory for the neurophysiological basis of primary consciousness was proposed by Gerald Edelman. This theory of consciousness is premised upon three major assumptions:

1. The laws of physics apply to consciousness, which rules out concepts such as spirits and a soul and allows for a purely physiological model of consciousness.
2. Consciousness is an evolved characteristic, which means it is a helpful characteristic from a Darwinian perspective.
3. There is no such thing as a " qualia-free" observer. Qualia are collections of personal or subjective experiences, feelings, and sensations that inevitably come with human awareness.[3]

Edelman's theory focuses on two nervous system organizations: the brainstem and limbic systems on one side and the thalamus and cerebral cortex on the other side. The brain stem and limbic system take care of essential body functioning and survival, while the thalamocortical system receives signals from sensory receptors and sends out signals to voluntary muscles such as those of the arms and legs. The theory asserts that the connection of these two systems during evolution helped animals learn adaptive behaviors.[1] This connection allows past signals related to values set by the limbic-brain stem system and categorized signals from the outside world to be correlated, resulting in memory in conceptual areas. This memory is then linked to the organism's *current* perception, which results in an awareness of the present, or primary consciousness. In other words, Edelman posits that primary consciousness arises from the correlation of *conceptual* memory to a set of *ongoing* perceptual categorizations—a "remembered present".[1]

Other scientists have argued against Edelman's theory, instead suggesting that primary consciousness might have emerged with the basic vegetative systems of the brain. That is, the evolutionary origin might have come from sensations and primal emotions arising from sensors and

receptors, both internal and surface, signaling that the well-being of the creature was immediately threatened—for example, hunger for air, thirst, hunger, pain, and extreme temperature change. This is based on neurological data showing the thalamic, hippocampal, orbitofrontal, insula, and midbrain sites are the key to consciousness of thirst.[4]

These scientists also point out that the cortex might not be as important to primary consciousness as some neuroscientists have believed.[4] Evidence of this lies in the fact that studies show that systematically disabling parts of the cortex in animals does not remove consciousness. Another study found that children born without a cortex are conscious. Instead of cortical mechanisms, these scientists emphasize brainstem mechanisms as essential to consciousness.[4] Still, these scientists concede that higher order consciousness does involve the cortex and complex communication between different areas of the brain.

Neurophysiological basis

Physiologically, three fundamental facts stand out about primary consciousness:[5]

1. Waking consciousness is associated with low amplitude, irregular EEG activity in the 20–70 Hz range.
   - Conversely, unconscious states like deep sleep, coma, general anesthesia, and epileptic states of absence show a predominance of low frequency, high- amplitude and more regular voltages at less than 4Hz.
2. Consciousness seems to be intrinsically associated with the thalamus and cortex, even if the extent to which this true is argued among scientists.
   - Damage to the brainstem or thalamus can abolish consciousness, while damage to the sensory cortex appears to delete specific conscious features such as color vision, visual motion, conscious experiences of objects and faces, and the like.
3. Consciousness is distinctively associated with widespread brain activation related to the conscious content.
   - Perhaps two dozen experiments show that sensory input supporting consciousness spreads from the sensory cortex to parietal, prefrontal, and medial-temporal cortex, while closely matched input that does not reach consciousness activates mainly local sensory regions. Further, the widespread activity appears to involve more globally coordinated activity.[5]

TOC Previous Next

Measurement

To be fully comprehensive, measures of consciousness must not only define and distinguish between conscious and unconscious states, but must also provide a guide by which the conscious level, or extent of consciousness, can be determined.[6] Measures of consciousness are each associated with particular theories.[7]

Certain defining theories are included below:

Worldly discrimination theory asserts that any mental state that is manifested in behavior is conscious; thus, an organism is consciously aware of something in the world if it can discriminate it with choice behavior. **Signal detection theory** quantifies discriminability of a stimulus among a set of different stimuli. **Integration theories** focus on finding a divide between conscious and unconscious processes. According to integration theories, conscious contents are widely available to many cognitive and/or neural processes.[8]

These theories are then accompanied with measures of the level of consciousness, which are subdivided into behavioral measures and physiological measures.[6]

TOC Previous Next

Behavioral measures

Behavioral measures of primary consciousness can be either objective or subjective. Regarding objective measures, knowledge is unconscious if it expresses itself in an indirect test. For example, the ability to pick which item might come next in a series can indicate unconscious knowledge of regularities in sequences.[7][8] "Strategic control measures" use a person's ability to deliberately use or not use knowledge according to instructions. If they use information despite intentions not to use it, it indicates unconscious knowledge.[7] Post-decision wagering can also be used. In this method, subjects make a first-order discrimination (i.e. a choice) and then

place a wager regarding the outcome of the discrimination. Some scientists view this as a direct and objective measure of consciousness, and it can be used with children and animals. However, this method has been argued to be subjective and indirect.[7]

TOC Previous Next

Physiological measures

Event-related cortical potentials (ERPs) have been used to assess whether a stimulus is consciously perceived or not. These EEG measures either float free of theory, gaining credibility through reliable correlation, or assume a version of integration theory in which the appearance of a particular ERP indicates global availability or locally recurrent processing.[9]

Abundant evidence indicates that consciously perceived inputs elicit widespread brain activation, as compared with inputs that do not reach consciousness.

The **dynamic core hypothesis (DCH)** proposes that consciousness arises from neural dynamics in the thalamocortical system, as measured by the quantity **neural complexity (CN).** *CN* is an information-theoretic measure; the *CN* value is high if each subset of a neural system can take on many different states, and if these states make a difference to the rest of the system.[5] The **information integration theory of consciousness (IITC)** shares with the DCH the idea that conscious experiences provide informative discriminations among a vast repertoire of possible experiences. In the IITC, the quantity *phi* is defined as the information that is integrated across the informational "weakest link" of a system. Importantly, *phi* is a measure of the capacity of a neural system to integrate information, whereas *CN* is a measure of the actual dynamics of the system. A third measure, **causal density *(CD)***, measures the fraction of causal interactions among elements of a system that are statistically significant.[5]

TOC Previous Next

Challenges in measuring

It is important to note that subjective measures are always indirect and can be vulnerable to many biases (e.g., reluctance to report uncertain experiences). Also, because metacognitive conscious content assumes primary consciousness but not vice versa, subjective measures risk missing or rejecting the presence of sensory consciousness simply because metacognition isn't observed.[6]

Furthermore, there is the problem of post-decision wagering, which has been criticized because there is a possibility that advantageous wagering could be learned unconsciously; as a result, post-decision wagering would not in fact be considered a conscious behavior. For example, individual differences in risk aversion may lead to variations in wagering performance even with the same underlying conscious phenomenology.[8]

Thus, although behavioral measures are mostly used for assessing which contents are conscious, some brain-based measures seem better suited for measuring conscious level. Objective measures also have their challenges, however. First, objective measures still require a response criterion, for example the decision of whether or not to push a button. Second, they may not even measure consciousness at all because many behavioral proxies, such as forced-choice decision accuracy, are capable of being learned unconsciously.[1][10]

TOC Previous Next

Miscellaneous studies

TOC Previous Next

In lucid dreams

Hobson asserts that the existence of lucid dreaming means that the human brain can simultaneously occupy two states: waking and dreaming. The dreaming portion has experiences and therefore has primary consciousness, while the waking self recognizes the dreaming and can be seen as having a sort of secondary consciousness in the sense that there is an awareness of mental state. Studies have been able to show that lucid dreaming is associated with EEG power and coherence profiles that are significantly different from both non-lucid dreaming and waking.[11] Lucid dreaming situates itself between those two states. Lucid dreaming is characterized by more 40 Hz power than non-lucid dreaming, especially in frontal regions. Since it is 40 Hz power that has been correlated with waking consciousness in previous studies, it can be suggested that enough 40 Hz power has been added to the non-lucid dreaming brain to support the increase in subjective awareness that permits lucidity but not enough to cause full awakening.[11]

Dreaming is thus a virtual reality experience with a remarkably predictive simulation of external reality. Lucid dreamers may experience primary consciousness (the dream) and secondary consciousness (the waking) separately but simultaneously. Moreover, primary consciousness has recently been proposed by us to be characteristic of dreaming. It remains to be seen whether the enactment of dream behaviors uses the same brain processes as those that mediate those very behaviors in waking, and whether conscious within a dream is governed by the same processes.[11]

TOC Previous Next

In epileptic seizures

Studies show that it is possible to retain primary consciousness and even

secondary consciousness during complex partial epileptic seizures. One study analyzed 40 patients with complex partial seizures to determine their level of consciousness during seizures. The data acquired was based on patients' subjective descriptions of their experience and descriptions from family members who witnessed the seizures.[2] This study found there was a complete absence of consciousness in only 65% of people during the core period of the seizures. Meanwhile, 35% of seizures included some form of primary consciousness. Five seizure descriptions even reported some form of secondary consciousness, albeit short and intermittent. The level and contents of consciousness during epileptic seizures show considerable variability.[2]

In thirst

In one study, 10 adult males underwent positron emission tomography scans in three different scenarios:[12]

1. During generation of moderate thirst by infusion of intravenous hypertonic saline 0.51 M
2. After wetting of the mouth with water to remove the sensation of dryness
3. 3, 14, 45, and 60 minutes after drinking water to fully quench thirst

The data suggest that the anterior and posterior cingulate cortex as well as the anterior wall of the third ventricle, are major elements of a circuit including thalamic, hippocampal, orbitofrontal, insula, and midbrain sites that are needed for the generation of consciousness of thirst.[12] This study shows that consciousness of some key sensations like thirst is governed by the oldest regions of the brain, which raises the question of whether it is really then possible to say when primary consciousness developed.[12]

TOC Previous Next

In meditation

In some types of meditation/yoga it is possible to have the experience known as Samadhi, where there is inner alertness but no object of consciousness.[13] This mental state corresponds with specific physiological parameters.[14]

References

1. ^ a b c d Edelman, G. (2004). *Wider than the sky: The phenomenal gift of consciousness*: Yale Univ Pr.
2. ^ a b c Johanson, M., Revonsuo, A., Chaplin, J., & Wedlund, J.-E. (2003). Level and contents of consciousness in connection with partial epileptic seizures. *Epilepsy & Behavior*, 4(3), 279–285.
3. ^ Edelman, G. (2003). Naturalizing consciousness: a theoretical framework. Proceedings of the National Academy of Sciences, 100(9), 5520.
4. ^ a b c Merker, B. (2007). Consciousness without a cerebral cortex: A challenge for neuroscience and medicine. *Behavioral and Brain Sciences*, 30(01), 63–81.
5. ^ a b c d Seth, A. K., & Baars, B. J. (2005). Neural Darwinism and consciousness. *Consciousness and Cognition*, 14(1), 140–168.
6. ^ a b c Morin, A. (2006). Levels of consciousness and self-awareness: A comparison and integration of various neurocognitive views. *Consciousness and Cognition*, 15(2), 358–371.
7. ^ a b c d Seth, A. K. (2008). Theories and measures of consciousness develop together. *Consciousness and Cognition*, 17(3), 986–988.
8. ^ a b c Seth, A. K., Dienes, Z., Cleeremans, A., Overgaard, M., & Pessoa, L. (2008). Measuring consciousness: relating behavioural and neurophysiological approaches. *Trends in Cognitive Sciences*, 12(8), 314–321.
9. ^ Seth, A. (2009). Explanatory Correlates of Consciousness: Theoretical and Computational Challenges. *Cognitive Computation*, 1(1), 50–63.
10. ^ Edelman, G. (2001). Consciousness: the remembered present. *Annals of the New York Academy of Sciences*, 929, 111–122.
11. ^ a b c Hobson, A. (2009). The neurobiology of consciousness: Lucid dreaming wakes up. *International Journal of Dream Research*, 2(2), 41–44.
12. ^ a b c Denton, D., Shade, R., Zamarippa, F., Egan, G., Blair-West, J., McKinley, M., et al. (1999). Neuroimaging of genesis and satiation of thirst and an interoceptor-driven theory of origins of primary

consciousness. *Proceedings of the National Academy of Sciences of the United States of America*, 96(9), 5304.

13. ^ Patanjali's Yoga Sutras.
14. ^ Travis, F. & Pearsoon. C. (2000) Pure Consciousness: Distinct phenomenological and physiological correlates of "consciousness itself", *International Journal of Neuroscience*, 100 pp. 77–89.

External links

- *Adam Zeman (2004). "Book Review: Wider than the sky: The phenomenal gift of consciousness ". J. Clin. Invest. doi: 10.1172/JCI23795. Retrieved 2008-06-25.*

Categories:

- Cognitive science
- Consciousness

This page was last edited on 20 October 2016, at 20:46.

Back to main TOC

Contents

Theory of Mediation

Jump to navigation Jump to search

The **theory of mediation**, which is the principal referent of the research group of the Interdisciplinary Laboratory for Language Research (L.I.R.L.), is a theoretic model developed at Rennes (France) since the 1960' by Professor Jean Gagnepain, linguist and epistemologist. This model, whose principles Jean Gagnepain has methodically set forth in his three volume study *On Meaning* (*Du Vouloir Dire*),[1][2] covers the whole field of the human sciences. One essential feature of the theory is that it seeks to find a kind of experimental verification of its theorems in the clinic of psychopathology. For this reason, the theory presents itself as a "clinical anthropology".

The theoretic model developed by Gagnepain and his research group at Rennes has inspired the work of professors and researchers in a number of European countries and in the United States in a wide variety of disciplinary fields, among them linguistics, literature, psychology, art history, archeology, psychoanalysis, theology. Its aim is deliberately trans-disciplinary - or, as Gagnepain humorously puts it, the theory of mediation cultivates "in-discipline".

A theory of culture

This model, originally developed with respect to language, today takes for its object the entirety of what is called "the cultural", that is, the dimension that specifies human beings and distinguishes them from other living species. In other words, "the cultural" constitutes the specific order of reality in which only human beings participate. It is the cultural order that permits human beings, while remaining natural beings, to constantly transcend their natural being in abstracting themselves from it.

The theory of mediation understands the cultural order - more simply, culture - not as the totality of the essential works of a society, nor as the general state of a given civilization, but as the ensemble of properly human capacities which, absent pathological conditions, all human beings share regardless of their historical epoch or geographical setting. For the theory of mediation, culture and reason - the "rationality" which philosophers have discussed for centuries - are identical. The human sciences, understood as the theory of mediation understands them, take up in their own distinctive fashion the questions which philosophy has treated only speculatively.

TOC | Previous | Next

A clinical anthropology

Gagnepain's work shows, on the basis of what the clinic forces us to recognize, that human reason is diffracted. In other words, rationality in human beings has several different forms which the clinic requires us to dissociate. Reason is logical, to be sure, but it is equally and just as fundamentally technical, ethnical, and ethical. There is no hierarchy among these different "planes" or "levels" of rationality that constitute psychic life.

On each of these planes or levels, human being mediate their relations to the world and others (thus the term "mediation"). Unlike the other animals, human beings are not limited to what their immediate physiological capacities allow them to grasp. They can stand back from, or take a distance from, their natural insertion in the world and can elaborate those cultural mediations that are constitutive of a properly human reality.

In Kantian terms, it is a question of passing from a description of an already constituted reason to an explanation of a constituting reason. It is a question, therefore, of accounting for that in human beings which, without their knowing it, makes them capable of posing the world - and of posing it not only in one way, by knowing it, as the traditional analysis holds, but in four different ways on the basis of four different capacities.

To be sure, human beings manifest the world in and across the words they speak : with them, they designate the world and explain it to themselves. In so doing, they realize their logical capacity. Human beings also manifest the world in and across their tools : with them, they fabricate the world and, in doing so, they realize their technical capacity. Human beings likewise manifest the world in originating their histories and societies, realizations not of their logical or their technical capacities but of their ethnic capacity. Finally, human beings manifest the world in the norms and regulations to which they submit their desires. Here is it question of their ethical capacity.

The possible autonomisation of the four planes (or levels or modes) of our

rationality is revealed by the clinic. Although "normally" the four modes of our rationality function together in such a way that it is hardly possible to distinguish them, pathologically it does become possible to distinguish them, as, for example, when one mode of rationality ceases to function in an afflicted person whereas the others continue to do so. Each plane of rationality has its specific pathology. The pathology specific to the logical plane is aphasia; the pathology specific to the technical plane is atechnia ; the pathology specific to the ethnical plane is psychosis (and perversion) ; the pathology specific to the ethical plane is neurosis (and psychopathic conditions).

In other words, pathology dissociates what normally cannot be distinguished and puts into evidence processes otherwise unseen. In this way, as Freud recognized, pathology provides a veritable analysis, that is, a breakdown, of the human psyche.[3] Gagnepain therefore makes it a methodological rule "to admit or to impute to a system only those dissociations that are pathologically verifiable."

TOC Previous Next

References

1. ^ Jean Gagnepain Jean, Du Vouloir Dire I, Bruxelles, De Boeck, 1990
2. ^ Jean Gagnepain Jean, Du Vouloir Dire II, Bruxelles, De Boeck, 1991
3. ^ "On the other hand, we are familiar with the notion that pathology, by making things larger and coarser, can draw our attention to normal conditions which would otherwise have escaped us. Where it points to a breach or a rent, there may normally be an articulation present. If we throw a crystal to the floor, it breaks; but not into haphazard pieces. It comes apart along its lines of cleavage into fragments whose boundaries, though they were invisible, were predetermined by the crystal's structure. Mental patients are split and broken structures of this same kind. [...] They have turned away from external reality, but for that very reason they know more about internal, psychical reality and can reveal a number of things to us that would otherwise be inaccessible to us." (S. Freund, *New Introductory Lectures on Psycho-Analysis*, lecture XXXI, 1933)

TOC Previous

External links

TOC Previous Next

Bibliography and Resources

- Gagnepain Jean (1990). Du Vouloir Dire I, Bruxelles, De Boeck. (in French)
- Gagnepain Jean (1991). Du Vouloir Dire II, Bruxelles, De Boeck. (in French)
- Gagnepain Jean (1994). Introductory Lessons to the Theory of Mediation (in french), Louvain, Peeters. A new corrected edition can be downloaded, under a new title, from the website of the Jean Gagnepain Institute : *Eight Introductory Lessons on the Theory of Mediation (in french)* (This numeric edition is now the reference edition).
- *Le Débat* 2006/3 (n° 140). has published a special issue on the theory of mediation (in French).
- Acts of the First International Colloquium of Clinical Anthropology, Anthropo-logiques 2 Louvain-La-Neuve, Peeters, 1989. (in French).
- Brackelaire Jean-Luc (1995). *La personne et la société. Principes et changements de l'identité et de la responsabilité*, Bruxelles, De Boeck. (in French)
- Dartiguenave Jean-Yves (2010). *Pour une sociologie du travail social*, Rennes, Presses Universitaires de Rennes. ISBN 978-2-7535-1168-2 (in French)
- Dartiguenave Jean-Yves et Garnier Jean-François (2008). *Un savoir de référence pour le travail social*, Toulouse, Érès. ISBN 978-2-7492-0883-1 (in French)
- Ewens Thomas (1997). « The Human Sciences in Question: Lonergan and Gagnepain », *Method. Journal of Lonergan Studies*, Volume 15, Number 1, Spring 1997. Available on LonerganResource
- Ewens Thomas (1994). « Rethinking the Question of Quality in Arts », *Arts Education Policy Review*, Volume 96, Issue 2.

- Ewens Thomas (1993). « Gramarye: or the Theory of Mediation and the Idea of the University », in Ed Block Jr. (Ed.), *Ideas for the University: Proceedings of Marquette University's Mission Seminar and Conference*, Milwaukee (WI), Marquette University Press, 1995. ISBN 978-0-8746-2002-3
- Ewens Thomas (1992). « Human Sciences and Art Education: The Theory of Mediation », *Design For Arts in Education*, Volume 93, Issue 6 (now *Arts Education Policy Review*). ISSN 1063-2913 (Print), ISSN 1940-4395 (Online)
- Guyard Hubert (2009). *La plainte douloureuse*, Rennes, Presses Universitaires de Rennes. ISBN 978-2-7535-0969-6 (in French).
- Le Bot Jean-Michel (2013), *The Social Bond and the Person. Toward a Clinical Sociology*, English translation of a condensed and slightly modified version of a book first published in French under the title *Le lien social et la personne. Pour une sociologie clinique*, Rennes, Presses Universitaires de Rennes, 2010. ISBN 978-2-7535-1210-8.
- Le Bot, J.-M., De Guibert, C., Beaud, L. and Gaborieau P. (2012). Clinical Anthropology and Animal Language, English translation of a paper first published in *Études Rurales*, 2012/1, n° 189, p. 75-90. http://halshs.archives-ouvertes.fr/halshs-00763708
- Le Gall Didier (1998). *Des apraxies aux atechnies*, Bruxelles, De Boeck (in French).
- Meurant Laurence (2008). *Le regard en langue des signes – Anaphore en langue des signes française de Belgique (LSFB) : morphologie, syntaxe, énonciation*, Presses universitaires de Namur et Presses universitaires de Rennes. ISBN 978-2-87037-588-4 (in French).
- Osiurak, F., Jarry, C., & Le Gall, D. (2011). Re-examining the gesture engram hypothesis. New perspectives on apraxia of tool use. *Neuropsychologia*, Volume 49, Issue 3, p. 299-312. DOI: 10.1016/j.neuropsychologia.2010.12.041
- Osiurak, F., Jarry, C., & Le Gall, D. (2010). Grasping the affordances. Understanding the reasoning. Toward a dialectical theory of human tool use. *Psychological Review*, Volume 117, Issue 2, p. 517-540. DOI: 10.1037/a0019004
- Osiurak, F., Jarry, C., Allain, P., Aubin, G., Etcharry-Bouyx, F.,

Richard, I., Bernard, I., & Le Gall, D. (2009). Unusual Use of objects after unilateral brain damage. The technical reasoning model. *Cortex*, Volume 45, Issue 6, p. 769-783. DOI: 10.1016/j.cortex.2008.06.013

- Quentel Jean-Claude (2007). *Les fondements des sciences humaines*, Toulouse, Erès. ISBN 978-2-7492-0772-8 (in French).
- Sabouraud Olivier (1995). *Le langage et ses maux*, Paris, Odile Jacob. ISBN 978-2-7381-0299-7 (in French)
- Schotte Jean-Claude (1997). *La raison éclatée*, Bruxelles, De Boeck. ISBN 2-8041-2625-0 / FR (in French)

TOC Previous

Further reading

- Jean Gagnepain Institute (in French)
- Website of the Interdisciplinary Laboratory for Language Research, Rennes, France (in French)
- More bibliographical references on the theory of mediation (in French)
- A tribute to professor Jean Gagnepain by Olivier Sabouraud on the website of the *Espace des sciences*, Rennes (in French)
- *Has the Theory of Mediation a Place in a Sociological Review ?* by Jean-Michel Le Bot, in *Socio-logos*, one-line review of the French Association of Sociology (in French).
- *Introduction to the Theory of Mediation* by Jean-Luc Lamotte.
- *Anthropology of Art* (in French)
- *Rethinking Technology II* by Thomas Ewens
- Deconstructing the Sacred with the Theory of Mediation, M.A. Dissertation in Religious Studies, by Bernard Couapel, University of lancaster (UK), 2005-2006 (download a pdf version)

Categories:

- Cognitive science

This page was last edited on 16 September 2017, at 18:32.

Back to main TOC

Bayesian cognitive Science

Jump to navigation Jump to search

Bayesian Cognitive Science (also known as Computational Cognitive Science) is a rapidly growing approach to cognitive science concerned with the rational analysis[1] of cognition through the use of Bayesian inference and cognitive modeling. The term "computational" refers to the computational level of analysis as put forth by David Marr.[2]

This work often consists of testing the hypothesis that cognitive systems behave like rational Bayesian agents in particular types of tasks. Past work has applied this idea to categorization, language, motor control, sequence learning, reinforcement learning and theory of mind. At other times, Bayesian rationality is *assumed*, and the goal is to infer the knowledge that agents have, and the mental representations that they use.

It is important to contrast this with the ordinary use of Bayesian inference in cognitive science, which is independent of rational modeling (see e.g. Michael Lee's work).

See also

- Active inference
- Bayesian approaches to brain function
- Bayesian programming
- Rational analysis

References

- T. L. Griffiths, and J. B. Tenenbaum (2006) "Optimal Predictions in Everyday Cognition" *Psychological Science 17(9), 767-773*.
- M. Oaksford and N. Chater (1999) - "Rational Models of Cognition"

1. ^ *Anderson, John (1990). Introduction. The Adaptive Character of Thought. Lawrence Erlbaum Associates.*
2. ^ *Marr, David (1971). The Philosophy and the Approach (PDF). Vision.*

TOP

Categories:

- Cognitive science

This page was last edited on 31 March 2017, at 10:31.

Back to main TOC

Contents

Simplicity Theory

Jump to navigation Jump to search

Simplicity theory is a cognitive theory that seeks to explain the attractiveness of situations or events to human minds. It is based on work done by scientists like Nick Chater, Paul Vitanyi, Jean-Louis Dessalles, and Jürgen Schmidhuber. It claims that interesting situations appear simpler than expected to the observer.

TOP

TOC Next

Overview

Technically, simplicity corresponds in a drop in Kolmogorov complexity, which means that, for an observer, the shortest description of the situation is shorter than anticipated. For instance, the description of a consecutive lottery draw, such as 22-23-24-25-26-27, is significantly shorter than a typical one, such as 12-22-27-37-38-42. The former requires only one instantiation (choice of a number among all possible numbers in the lottery), whereas the latter requires six instantiations.

Simplicity theory makes several quantitative predictions concerning the way distance, recency, prominence (places, individuals), or atypicality influence interestingness.

TOC Previous Next

Formalization

The basic concept of simplicity theory is *unexpectedness*, defined as the difference between expected complexity and observed complexity:

In most contexts, corresponds to *generation* complexity, which is the smallest description of all parameters that must be set in the "world" for the situation to exist. In the lottery example, generation complexity is identical for a consecutive draw and a typical draw (as long as no cheating is imagined) and amounts to six instantiations.

Simplicity theory avoids most criticisms addressed at Kolmogorov complexity by considering only descriptions that are *available* to a given *observer* (instead of any imaginable description). This amounts to saying that complexity, and thus unexpectedness, are observer-dependent. For instance, the typical draw 12-22-27-37-38-42 will appear very simple, even simpler than the consecutive one, to the person who played that combination.

TOC | Previous | Next

Connection with probability

Unexpectedness is linked to subjective probability as

The advantage of this formula is that subjective probability can be assessed without necessarily knowing the alternatives. Classical approaches to probability would consider all situations in the world as having virtually zero probability to have occurred, as each situation is complex and unique. Simplicity theory avoids this trap by considering that subjective improbability is only due to complexity drop.

References

- Chater, N. (1999). The search for simplicity: A fundamental cognitive principle? *The Quarterly Journal of Experimental Psychology*, 52 (A), 273–302.
- Chater, N. & Vitányi, P. (2003). Simplicity: a unifying principle in cognitive science?. *Trends in cognitive sciences*, 7 (1), 19–22.
- *Dessalles, Jean-Louis (2008). La pertinence et ses origines cognitives. Paris: Hermes-Science Publications. ISBN 978-2-7462-2087-4*.
- Dessalles, Jean-Louis (2010). Have you something unexpected to say? (PDF). The evolution of language – Proceedings of the 8th International Conference (Evolang8 - Utrecht), 99–106. Singapore: World Scientific.
- Feldman, J. (2004). How surprising is a simple pattern? Quantifying "Eureka!". *Cognition*, 93, 199–224.
- Schmidhuber, J. (1997). What’s interesting? Lugano, CH: Technical Report IDSIA-35-97.

TOC Previous

External links

- A tutorial on Simplicity Theory
- Juergen Schmidhuber's page on interest and low complexity

Categories:

- Cognitive science

This page was last edited on 12 May 2017, at 10:43.

Back to main TOC

Rational Analysis

Jump to navigation Jump to search

Rational analysis is a theoretical framework, methodology, and research program in cognitive science that has been developed by John Anderson.[1][2] The goal of rational analysis as a research program is to explain the function and purpose of cognitive processes and to discover the structure of the mind. Chater and Oaksford contrast it with the mechanistic explanations of cognition offered by both computational models and neuroscience.[3]

Rational analysis starts from the assumption that the mind is adapted to its environment. Rational analysis uses this assumption to investigate the structure and purpose of representations and cognitive processes by studying the structure of the environment. The methodology of rational analysis comprises six steps:[1][3]

1. Goals: Specify precisely the goals of the cognitive system.
2. Environment: Develop a formal model of the environment to which the system is adapted.
3. Computational Limitations: Make the minimal assumptions about computational limitations.
4. Optimization: Derive the optimal behavioral function given 1-3 above.
5. Data: Examine the empirical literature to see whether the predictions of the behavioral function are confirmed.
6. Iteration: Repeat, iteratively refining the theory

Rational analysis has been applied to memory, categorization, causal inference, problem solving,[2] and reasoning.[4]

References

1. ^ a b *Anderson, J. R. (1991). "Is human cognition adaptive?". Behavioral and Brain Sciences. **14**: 471–517. doi:10.1017/s0140525x00070801.*
2. ^ a b Anderson, J. R. (1990). "The adaptive character of thought". Hillsdale, NJ: Lawrence Erlbaum Associates.
3. ^ a b *Chater, N.; Oaksford, M. (1999). "Ten years of the rational analysis of cognition" (PDF). Trends in Cognitive Sciences. **3** (2): 57–65. doi:10.1016/s1364-6613(98)01273-x.*
4. ^ *Oaksford, M.; Chater, N. (1994). "A rational analysis of the selection task as optimal data selection". Psychological Review. **101** (4): 608–631. doi:10.1037/0033-295x.101.4.608.*

TOP

Categories:

- Analysis
- Cognitive science
- Cognitive psychology

Back to main TOC

Cognitive Sociology

Jump to navigation Jump to search

Cognitive sociology is a sociological sub-discipline devoted to the study of the "conditions under which meaning is constituted through processes of reification."[1] It does this by focusing on "the series of interpersonal processes that set up the conditions for phenomena to become "social objects," which subsequently shape thinking and thought."[1] Thus, this research aims to sort out the social and cultural contingencies and consequences of human cognition. It has its roots in classical sociological theory, notably Durkheim and Weber, and from contemporary sociological theory, notably Goffman and Bourdieu.[1]

Notable authors include but are not limited to, Eviatar Zerubavel, Aaron Cicourel, Barry Schwartz, Karen A. Cerulo and Paul DiMaggio.[2]

The term 'cognitive sociology' was used already in 1974 by Cicourel.[3] However, in 1997 DiMaggio[4] published what has been referred to as a now classic paper[5] of Cognitive Sociology in its current form.

Special journal issues on the topic of Cognitive Sociology has been published by the scientific journals Poetics[6] and the European Journal of Social Theory[7] in 2010 and 2007 respectively.

Graduate-level courses in cognitive sociology has been organized at the University of Copenhagen by Jacob Strandell in 2014 and 2016 [8][9]

In order to organize this interdisciplinary investigation, scholars have articulated five models of the actor that stress different locations of human cognition in relation to the social contract.[10] These models are:

1. **Universal cognitivism** stresses "naturalistic explanations of human behavior".[1] This is reflected in the work of Stephen P. Turner,[11]

Omar Lizardo[12] and Gabriel Ignatow.[13]

2. **Fuzzy universal cognitivism** "emphasizes naturalism in the explanations, but its ontological positions are not as balanced as plural cognitivism".[1] This is reflected in the work of Jürgen Habermas[14] and Paul DiMaggio.
3. **Plural cognitivism** seeks to formulate a "balanced model of the actor subjected to socio-mental control. Socio-mental control describes how impersonal cognitive norms shape the thinking, learning, and courses of activity individual actors *are able to undertake* as a result of institutional reflexivity."[1] Institutional reflexivity is a process described by Goffman in "The Arrangement between the Sexes".[15] This is reflected in the work of Eviatar Zerubavel and his students.
4. **Fuzzy individual cognitivism** "emphasizes humanism in the explanations, but its ontological positions are not as balanced as plural cognitivism".[1] This is reflected in the work of Luc Boltanski and Laurent Thévenot[16] as well as Alban Bouvier.[17]
5. **Individual cognitivism** investigates the "inner determinants of action with respect to the practical, cognitive, and moral properties of social facts."[1] This is reflected in the work of Raymond Boudon and Patrick Pharo.[18]

References

1. ^ a b c d e f g h Raphael, Michael W. (2017). "Cognitive Sociology". *Oxford Bibliographies Online in Sociology*. **187**. doi:10.1093/obo/9780199756384-0187.
2. ^ Cerulo, Karen (2014). "Cognitive Sociology". *Encyclopedia of Social Theory*: 108–112.
3. ^ Cicourel, Aaron (1974). *Cognitive Sociology: Language and Meaning in Social Interaction*. New Tork: Free Press.
4. ^ DiMaggio, Paul (1997). "Culture and Cognition". *Annual Review of Sociology*. **23** (1): 263–287. doi:10.1146/annurev.soc.23.1.263.
5. ^ Cerulo, Karen (2010). "Mining the Intersection of Cognitive Sociology and Neuroscience". *Poetics*. **38** (2): 115–132. doi:10.1016/j.poetic.2009.11.005.
6. ^ Cerulo, Karen (2010). "Brain, Mind and Cultural Sociology". *Poetics*. **38** (2).
7. ^ Strydom, Piet (2007). "Social Theory after the Cognitive Revolution". *European Journal of Social Theory*. **10** (3).
8. ^ University of Copenhagen. "Cognitive Sociology: Self, Identity and Self-Esteem". Retrieved 10 November 2014.
9. ^ Universitet, Københavns. "Culture-Cognition Interaction in Self- and Identity - 2015/2016". *kurser.ku.dk*. Retrieved 2018-02-10.
10. ^ Raphael, Michael W. (2015). "On the Prospect of a Cognitive Sociology of Law: Recognizing the Inequality of Contract". *Annual Meeting of the Mid-Atlantic Law and Society Association* – via CUNY Academic Works.
11. ^ Turner, Stephen P. (2002). *Brains/practices/relativism: Social theory after cognitive science*. Chicago: Univ. of Chicago Press.
12. ^ Lizardo, Omar (2012). "The conceptual bases of metaphors of dirt and cleanliness in moral and non-moral reasoning". *Cognitive Linguistics*. **23** (2). doi:10.1515/cog-2012-0011. ISSN 1613-3641.
13. ^ Ignatow, Gabriel (2009). "Culture and Embodied Cognition: Moral Discourses in Internet Support Groups for Overeaters". *Social Forces*. **88** (2): 643–669. doi:10.1353/sof.0.0262.
14. ^ Strydom, Piet (2015). "The latent cognitive sociology in Habermas:

Extrapolated from Between Facts and Norms". *Philosophy & Social Criticism*. **41** (3): 273–291. doi:10.1177/0191453714563877.
15. ^ Goffman, Erving (1977). *"The Arrangement between the Sexes"*. *Theory and Society*. **4** (3): 301–331. doi:10.1007/bf00206983.
16. ^ Boltanski, Luc; Thévenot, Laurent (2000). *"The reality of moral expectations: A sociology of situated judgement"*. *Philosophical Explorations*. **3** (3): 208–231. doi:10.1080/13869790008523332. ISSN 1386-9795.
17. ^ Bouvier, A. (2007). *"An Argumentativist Point of View in Cognitive Sociology"*. *European Journal of Social Theory*. **10** (3): 465–480. doi:10.1177/1368431007080707.
18. ^ Pharo, P. (2007). *"How is Sociological Realism Possible?: Sociology after Cognitive Science"*. *European Journal of Social Theory*. **10** (3): 481–496. doi:10.1177/1368431007080708.

TOP

Categories:

- Behavioural sciences
- Subfields of sociology
- Cognitive science

This page was last edited on 17 February 2018, at 20:26.

Back to main TOC

Contents

Visual Modularity

Jump to navigation Jump to search

In cognitive neuroscience, **visual modularity** is an organizational concept concerning how vision works. The way in which the primate visual system operates is currently under intense scientific scrutiny. One dominant thesis is that different properties of the visual world (color, motion, form and so forth) require different computational solutions which are implemented in anatomically/functionally distinct regions that operate independently – that is, in a modular fashion.[1]

TOP

TOC Next

Motion processing

Akinetopsia is an intriguing condition brought about by damage to the Extrastriate cortex MT+ that renders humans and monkeys unable to perceive motion, seeing the world in a series of static "frames" instead[2][3][4][5] and indicates that there might be a "motion centre" in the brain. Of course, such data can only indicate that this area is at least necessary to motion perception, not that it is sufficient; however, other evidence has shown the importance of this area to primate motion perception. Specifically, physiological, neuroimaging, perceptual, electrical- and transcranial magnetic stimulation evidence (Table 1) all come together on the area V5/hMT+. Converging evidence of this type is supportive of a module for motion processing. However, this view is likely to be incomplete: other areas are involved with motion perception, including V1,[6][7][8] V2 and V3a [9] and areas surrounding V5/hMT+ (Table 2). A recent fMRI study put the number of motion areas at twenty-one.[10] Clearly, this constitutes a stream of diverse anatomical areas. The extent to which this is ‘pure’ is in question: with Akinetopsia come severe difficulties in obtaining structure from motion.[11] V5/hMT+ has since been implicated in this function[12] as well as determining depth.[13] Thus the current evidence suggests that motion processing occurs in a modular stream, although with a role in form and depth perception at higher levels.

Color processing

Similar converging evidence suggests modularity for color. Beginning with Gowers' finding[28] that damage to the fusiform/lingual gyri in occipitotemporal cortex correlates with a loss in color perception (achromatopsia), the notion of a "color centre" in the primate brain has had growing support.[29][30][31] Again, such clinical evidence only implies that this region is critical to color perception, and nothing more. Other evidence, however, including neuroimaging [10][32][33] and physiology[34][35] converges on V4 as necessary to color perception. A recent meta-analysis has also shown a specific lesion common to achromats corresponding to V4.[36] From another direction altogether it has been found that when synaesthetes experience color by a non-visual stimulus, V4 is active.[37][38] On the basis of this evidence it would seem that color processing is modular. However, as with motion processing it is likely that this conclusion is inaccurate. Other evidence shown in Table 3 implies different areas' involvement with color. It may thus be more instructive to consider a multistage color processing stream from the retina through to cortical areas including at least V1 , V2 , V4 , PITd and TEO. Consonant with motion perception, there appears to be a constellation of areas drawn upon for color perception . In addition, V4 may have a special, but not exclusive, role. For example, single cell recording has shown that only V4 cells respond to the color of a stimuli rather than its waveband, whereas other areas involved with color do not.[34][35]

TOC Previous Next

Form processing

Another clinical case that would a priori suggest a module for modularity in visual processing is visual agnosia. The well studied patient DF is unable to recognize or discriminate objects[48] owing to damage in areas of the lateral occipital cortex although she can see scenes without problem – she can literally see the forest but not the trees.[49] Neuroimaging of intact individuals reveals strong occipito-temporal activation during object presentation and greater activation still for object recognition.[50] Of course, such activation could be due to other processes, such as visual attention. However, other evidence that shows a tight coupling of perceptual and physiological changes[51] suggests activation in this area does underpin object recognition. Within these regions are more specialized areas for face or fine grained analysis,[52] place perception[53] and human body perception.[54] Perhaps some of the strongest evidence for the modular nature of these processing systems is the double dissociation between object- and face (prosop-) agnosia. However, as with color and motion, early areas (see [45] for a comprehensive review) are implicated too, lending support to the idea of a multistage stream terminating in the inferotemporal cortex rather than an isolated module.

Functional modularity

One of the first uses of the term "module" or "modularity" occurs in the influential book "Modularity of Mind" by philosopher Jerry Fodor.[55] A detailed application of this idea to the case of vision was published by Pylyshyn (1999), who argued that there is a significant part of vision that is not responsive to beliefs and is "cognitively impenetrable".[56]

Much of the confusion concerning modularity exists in neuroscience because there is evidence for specific areas (e.g. V4 or V5/hMT+) and the concomitant behavioral deficits following brain insult (thus taken as evidence for modularity). In addition, evidence shows other areas are involved and that these areas subserve processing of multiple properties (e.g. V1[57]) (thus taken as evidence against modularity). That these streams have the same implementation in early visual areas, like V1, is not inconsistent with a modular viewpoint: to adopt the canonical analogy in cognition, it is possible for different software to run on the same hardware. A consideration of psychophysics and neuropsychological data would suggest support for this. For example, psychophysics has shown that percepts for different properties are realized asynchronously.[23][24] In addition, although achromats experience other cognitive defects[58] they do not have motion deficits when their lesion is restricted to V4, or total loss of form perception.[59] Relatedly, Zihl and colleagues' akinetopsia patient shows no deficit to color or object perception (although deriving depth and structure from motion is problematic, see above) and object agnostics do not have damaged motion or color perception, making the three disorders triply dissociable.[3] Taken together this evidence suggests that even though distinct properties may employ the same early visual areas they are functionally independent. Furthermore, that the intensity of subjective perceptual experience (e.g. color) correlates with activity in these specific areas (e.g. V4),[32] the recent evidence that synaesthetes show V4 activation during the perceptual experience of color, as well as the fact that damage to these areas results in concomitant behavioral deficits (the processing may be occurring but perceivers do not have access to the information) are all evidence for visual modularity.

See also

- Heautoscopy
- Modularity
- *Society of Mind* which proposes the mind is made up of agents
- Two streams hypothesis

TOC Previous

References

1. ^ *Calabretta,, R.; Parisi, D. (2005). "Evolutionary Connectionism and Mind/Brain Modularity". Modularity. Understanding the development and evolution of complex natural systems. Cambridge, MA: MIT Press.* ***361*** *(1467): 309–330. doi:10.1098/rstb.2005.1807. PMC 1609335 . PMID 16524839.*
2. ^ *a b Zihl J, von Cramon D, Mai N, Schmid C (1991). "Disturbance of movement vision after bilateral posterior brain damage". Brain.* ***114*** *(144): 2235–2252. doi:10.1093/brain/114.5.2235. PMID 1933243.*
3. ^ *a b c Zihl, J.; von Cramon, D.Y.; Mai, N. (1983). "Selective disturbances of movement vision after bilateral brain damage". Brain.* ***106*** *(2): 313–340. doi:10.1093/brain/106.2.525-a.*
4. ^ *a b Hess RH, Baker CL, Zihl J (1989). "The "motion-blind" patient: low-level spatial and temporal filters". J. Neurosci.* ***9*** *(5): 1628–40. PMID 2723744.*
5. ^ *a b Baker CL, Hess RF, Zihl J (1991). "Residual motion perception in a" motion-blind" patient, assessed with limited-lifetime random dot stimuli". Journal of Neuroscience.* ***11*** *(2): 454–461. PMID 1992012.*
6. ^ *Orban, G.A.; Kennedy, H.; Bullier, J. (1986). "Velocity sensitivity and direction selectivity of neurons in areas V1 and V2 of the monkey: influence of eccentricity". Journal of Neurophysiology.* ***56*** *(2): 462–480. doi:10.1016/j.jphysparis.2004.03.004. PMID 3760931.*
7. ^ *Movshon, J.A.; Newsome, W.T. (1996). "Visual response properties of striate cortical neurons projecting to area MT in macaque monkeys". Journal of Neuroscience.* ***16*** *(23): 7733–7741. PMID 8922429.*
8. ^ *Born, R.T.; Bradley, D.C. (2005). "Structure and function of visual area MT". Annual Review of Neuroscience.* ***28****: 157–189. doi:10.1146/annurev.neuro.26.041002.131052. PMID 16022593.*
9. ^ *Grill-Spector, K.; Malach, R. (2004). "The Human Visual Cortex". Annual Review of Neuroscience.* ***27****: 649–677. doi:10.1146/annurev.neuro.27.070203.144220. PMID 15217346.*
10. ^ *a b c Stiers P, Peeters R, Lagae L, Van Hecke P, Sunaert S (Jan 1, 2006). "Mapping multiple visual areas in the human brain with a*

short fMRI sequence". NeuroImage. ***29*** *(1): 74–89. doi:10.1016/j.neuroimage.2005.07.033. PMID 16154766. Retrieved 28 April 2013.*

11. ^ *Rizzo, Matthew; Nawrot, Mark; Zihl, Josef (1 January 1995). "Motion and shape perception in cerebral akinetopsia". Brain.* ***118*** *(5): 1105–1127. doi:10.1093/brain/118.5.1105. PMID 7496774.*
12. ^ *Grunewald, A; Bradley, DC; Andersen, RA (Jul 15, 2002). "Neural correlates of structure-from-motion perception in macaque V1 and MT". The Journal of Neuroscience.* ***22*** *(14): 6195–207. PMID 12122078.*
13. ^ *DeAngelis, GC; Cumming, BG; Newsome, WT (Aug 13, 1998). "Cortical area MT and the perception of stereoscopic depth". Nature.* ***394*** *(6694): 677–80. doi:10.1038/29299. PMID 9716130.*
14. ^ *Zeki, SM (Feb 1974). "Functional organization of a visual area in the posterior bank of the superior temporal sulcus of the rhesus monkey". The Journal of Physiology.* ***236*** *(3): 549–73. doi:10.1113/jphysiol.1974.sp010452. PMC 1350849 . PMID 4207129.*
15. ^ *Van Essen, D. C.; Maunsell, J. H. R.; Bixby, J. L. (1 July 1981). "The middle temporal visual area in the macaque: Myeloarchitecture, connections, functional properties and topographic organization". The Journal of Comparative Neurology.* ***199*** *(3): 293–326. doi:10.1002/cne.901990302. PMID 7263951.*
16. ^ *Maunsell, JH; Van Essen, DC (May 1983). "Functional properties of neurons in middle temporal visual area of the macaque monkey. I. Selectivity for stimulus direction, speed, and orientation". Journal of Neurophysiology.* ***49*** *(5): 1127–47. PMID 6864242.*
17. ^ *Felleman, DJ; Kaas, JH (Sep 1984). "Receptive-field properties of neurons in middle temporal visual area (MT) of owl monkeys". Journal of Neurophysiology.* ***52*** *(3): 488–513. PMID 6481441.*
18. ^ *Culham, JC; Brandt, SA; Cavanagh, P; Kanwisher, NG; Dale, AM; Tootell, RB (Nov 1998). "Cortical fMRI activation produced by attentive tracking of moving targets". Journal of Neurophysiology.* ***80*** *(5): 2657–70. PMID 9819271.*
19. ^ *Salzman, CD; Murasugi, CM; Britten, KH; Newsome, WT (Jun 1992). "Microstimulation in visual area MT: effects on direction discrimination performance". The Journal of Neuroscience.* ***12*** *(6):*

2331–55. PMID 1607944.

20. ^ *Hotson, John; Braun, Doris; Herzberg, William; Boman, Duane (1994). "Transcranial magnetic stimulation of extrastriate cortex degrades human motion direction discrimination". Vision Research.* ***34*** *(16): 2115–2123. doi:10.1016/0042-6989(94)90321-2. PMID 7941409.*
21. ^ *Beckers, G.; Zeki, S. (1 January 1995). "The consequences of inactivating areas V1 and V5 on visual motion perception". Brain.* ***118*** *(1): 49–60. doi:10.1093/brain/118.1.49. PMID 7895014.*
22. ^ *Walsh, V; Cowey, A (Mar 1, 1998). "Magnetic stimulation studies of visual cognition". Trends in Cognitive Sciences.* ***2*** *(3): 103–10. doi:10.1016/S1364-6613(98)01134-6. PMID 21227086.*
23. ^ ***a*** ***b*** *Moutoussis, K.; Zeki, S. (22 March 1997). "A direct demonstration of perceptual asynchrony in vision". Proceedings of the Royal Society B: Biological Sciences.* ***264*** *(1380): 393–399. doi:10.1098/rspb.1997.0056. PMC 1688275 . PMID 9107055.*
24. ^ ***a*** ***b*** *Viviani, Paolo; Aymoz, Christelle (1 October 2001). "Colour, form, and movement are not perceived simultaneously". Vision Research.* ***41*** *(22): 2909–2918. doi:10.1016/S0042-6989(01)00160-2. PMID 11701183.*
25. ^ *Tanaka, K; Saito, H (Sep 1989). "Analysis of motion of the visual field by direction, expansion/contraction, and rotation cells clustered in the dorsal part of the medial superior temporal area of the macaque monkey". Journal of Neurophysiology.* ***62*** *(3): 626–41. PMID 2769351.*
26. ^ *Grossman, E; Donnelly, M; Price, R; Pickens, D; Morgan, V; Neighbor, G; Blake, R (Sep 2000). "Brain areas involved in perception of biological motion". Journal of Cognitive Neuroscience.* ***12*** *(5): 711–20. doi:10.1162/089892900562417. PMID 11054914.*
27. ^ *Beauchamp, MS; Lee, KE; Haxby, JV; Martin, A (Oct 1, 2003). "FMRI responses to video and point-light displays of moving humans and manipulable objects". Journal of Cognitive Neuroscience.* ***15*** *(7): 991–1001. doi:10.1162/089892903770007380. PMID 14614810.*
28. ^ *Gowers, W. (1888). A manual of diseases of the brain. J & A Churchill.*
29. ^ *Meadows, JC (Dec 1974). "Disturbed perception of colours associated with localized cerebral lesions". Brain : a journal of*

neurology. ***97*** *(4): 615–32. doi:10.1093/brain/97.1.615. PMID 4547992.*
30. ^ *Zeki, S. (1 January 1990). "Parallelism and Functional Specialization in Human Visual Cortex". Cold Spring Harbor Symposia on Quantitative Biology.* ***55*** *(0): 651–661. doi:10.1101/SQB.1990.055.01.062.*
31. ^ *Grüsser and Landis (1991). Visual agnosias and other disturbances of visual perception and cognition. MacMillan. pp. 297–303.*
32. ^ ***a b*** *Bartels, A. & Zeki, S. (2005). "Brain dynamics during natural viewing conditions - a new guide for mapping connectivity in vivo". NeuroImage.* ***24*** *(2): 339–349. doi:10.1016/j.neuroimage.2004.08.044. PMID 15627577. "no"*
33. ^ *Bartels, A. & Zeki, S. (2000). "The architecture of the colour centre in the human visual brain: new results and a review". European Journal of Neuroscience.* ***12*** *(1): 172–193. doi:10.1046/j.1460-9568.2000.00905.x. PMID 10651872. "no"*
34. ^ ***a b*** *Wachtler, T; Sejnowski, TJ; Albright, TD (Feb 20, 2003). "Representation of color stimuli in awake macaque primary visual cortex". Neuron.* ***37*** *(4): 681–91. doi:10.1016/S0896-6273(03)00035-7. PMC 2948212 . PMID 12597864.*
35. ^ ***a b*** *Kusunoki, M; Moutoussis, K; Zeki, S (May 2006). "Effect of background colors on the tuning of color-selective cells in monkey area V4". Journal of Neurophysiology.* ***95*** *(5): 3047–59. doi:10.1152/jn.00597.2005. PMID 16617176.*
36. ^ *Bouvier, S. E.; Engel, SA (27 April 2005). "Behavioral Deficits and Cortical Damage Loci in Cerebral Achromatopsia". Cerebral Cortex.* ***16*** *(2): 183–191. doi:10.1093/cercor/bhi096. PMID 15858161.*
37. ^ *Rich, AN; Williams, MA; Puce, A; Syngeniotis, A; Howard, MA; McGlone, F; Mattingley, JB (2006). "Neural correlates of imagined and synaesthetic colours". Neuropsychologia.* ***44*** *(14): 2918–25. doi:10.1016/j.neuropsychologia.2006.06.024. PMID 16901521.*
38. ^ *Sperling, JM; Prvulovic, D; Linden, DE; Singer, W; Stirn, A (Feb 2006). "Neuronal correlates of colour-graphemic synaesthesia: a fMRI study". Cortex.* ***42*** *(2): 295–303. doi:10.1016/S0010-9452(08)70355-1. PMID 16683504.*
39. ^ *Livingstone, MS; Hubel, DH (Jan 1984). "Anatomy and physiology of a color system in the primate visual cortex". The Journal of*

Neuroscience. **4** (1): 309–56. PMID 6198495.
40. ^ DeYoe, EA; Van Essen, DC (Sep 5–11, 1985). "Segregation of efferent connections and receptive field properties in visual area V2 of the macaque". *Nature*. **317** (6032): 58–61. doi:10.1038/317058a0. PMID 2412132.
41. ^ Zeki, S; Marini, L (1998). "Three cortical stages of colour processing in the human brain". *Brain*. **121** (9): 1669–1685. doi:10.1093/brain/121.9.1669. PMID 9762956.
42. ^ Beauchamp, MS; Haxby, JV; Rosen, AC; DeYoe, EA (2000). "A functional MRI case study of acquired cerebral dyschromatopsia". *Neuropsychologia*. **38** (8): 1170–9. doi:10.1016/S0028-3932(00)00017-8. PMID 10838151.
43. ^ Conway, B. R.; Tsao, DY (22 December 2005). "Color Architecture in Alert Macaque Cortex Revealed by fMRI". *Cerebral Cortex*. **16** (11): 1604–1613. doi:10.1093/cercor/bhj099. PMID 16400160.
44. ^ Tootell, R. B.H.; Nelissen, K; Vanduffel, W; Orban, GA (1 April 2004). "Search for Color 'Center(s)' in Macaque Visual Cortex". *Cerebral Cortex*. **14** (4): 353–363. doi:10.1093/cercor/bhh001. PMID 15028640.
45. ^ ***a*** ***b*** Pasupathy, A (2006). "Neural basis of shape representation in the primate brain". *Progress in brain research. Progress in Brain Research*. **154**: 293–313. doi:10.1016/S0079-6123(06)54016-6. ISBN 9780444529664. PMID 17010719.
46. ^ David, SV; Hayden, BY; Gallant, JL (Dec 2006). "Spectral receptive field properties explain shape selectivity in area V4". *Journal of Neurophysiology*. **96** (6): 3492–505. doi:10.1152/jn.00575.2006. PMID 16987926.
47. ^ Chelazzi, L; Miller, EK; Duncan, J; Desimone, R (Aug 2001). "Responses of neurons in macaque area V4 during memory-guided visual search". *Cerebral cortex (New York, N.Y. : 1991)*. **11** (8): 761–72. doi:10.1093/cercor/11.8.761. PMID 11459766.
48. ^ Mishkin, Mortimer; Ungerleider, Leslie G.; Macko, Kathleen A. (1983). "Object vision and spatial vision: two cortical pathways". *Trends in Neurosciences*. **6**: 414–417. doi:10.1016/0166-2236(83)90190-X.
49. ^ Steeves, Jennifer K.E.; Culham, Jody C.; Duchaine, Bradley C.; Pratesi, Cristiana Cavina; Valyear, Kenneth F.; Schindler, Igor;

Humphrey, G. Keith; Milner, A. David; Goodale, Melvyn A. (2006). "The fusiform face area is not sufficient for face recognition: Evidence from a patient with dense prosopagnosia and no occipital face area". Neuropsychologia. ***44*** *(4): 594–609. doi:10.1016/j.neuropsychologia.2005.06.013. PMID 16125741.*

50. ^ *Grill-Spector, Kalanit; Ungerleider, Leslie G.; Macko, Kathleen A. (2003). "The neural basis of object perception". Current Opinion in Neurobiology.* ***13*** *(3): 399. doi:10.1016/S0959-4388(03)00060-6.*
51. ^ *Sheinberg, DL; Logothetis, NK (Feb 15, 2001). "Noticing familiar objects in real world scenes: the role of temporal cortical neurons in natural vision". The Journal of Neuroscience.* ***21*** *(4): 1340–50. PMID 11160405.*
52. ^ *Gauthier, I; Skudlarski, P; Gore, JC; Anderson, AW (Feb 2000). "Expertise for cars and birds recruits brain areas involved in face recognition". Nature Neuroscience.* ***3*** *(2): 191–7. doi:10.1038/72140. PMID 10649576.*
53. ^ *Epstein, R; Kanwisher, N (Apr 9, 1998). "A cortical representation of the local visual environment". Nature.* ***392*** *(6676): 598–601. doi:10.1038/33402. PMID 9560155.*
54. ^ *Downing, PE; Jiang, Y; Shuman, M; Kanwisher, N (Sep 28, 2001). "A cortical area selective for visual processing of the human body". Science.* ***293*** *(5539): 2470–3. doi:10.1126/science.1063414. PMID 11577239.*
55. ^ *Fodor, Jerry A. (1989). The modularity of mind : an essay on faculty psychology (6. printing. ed.). Cambridge, Mass. [u.a.]: MIT Press. ISBN 0-262-56025-9.*
56. ^ *Pylyshyn, Z (Jun 1999). "Is vision continuous with cognition? The case for cognitive impenetrability of visual perception". The Behavioral and Brain Sciences.* ***22*** *(3): 341–65; discussion 366–423. doi:10.1017/s0140525x99002022. PMID 11301517.*
57. ^ *Leventhal, AG; Thompson, KG; Liu, D; Zhou, Y; Ault, SJ (Mar 1995). "Concomitant sensitivity to orientation, direction, and color of cells in layers 2, 3, and 4 of monkey striate cortex". The Journal of Neuroscience.* ***15*** *(3 Pt 1): 1808–18. PMID 7891136.*
58. ^ *Gegenfurtner, Karl R. (2003). "Sensory systems: Cortical mechanisms of colour vision". Nature Reviews Neuroscience.* ***4*** *(7): 563–572. doi:10.1038/nrn1138. PMID 12838331.*

59. ^ *Zeki, S (Jun 29, 2005). "The Ferrier Lecture 1995 behind the seen: the functional specialization of the brain in space and time". Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences.* ***360*** *(1458): 1145–83. doi:10.1098/rstb.2005.1666. PMC 1609195 . PMID 16147515.*

Categories:

- Cognitive neuroscience
- Cognitive science
- Visual system

This page was last edited on 9 November 2017, at 01:49.

Back to main TOC

Cognitive approaches to Grammar

Jump to navigation Jump to search

Cognitive approaches to grammar are theories of grammar that relate grammar to mental processes and structures in human cognition. While Chomsky's theories of generative grammar are the most influential in most areas of linguistics, other theories also deal with the cognitive aspects of grammar.

The approach of Noam Chomsky and his fellow generative grammarians is that of an autonomous mental faculty that it is governed by mental processes operating on mental representations of different kinds of symbols that apply only within this faculty.

Another cognitive approach to grammar is that which is proposed by proponents of cognitive linguistics, which holds that grammar is not an autonomous mental faculty with processes of its own, but that it is intertwined with all other cognitive processes and structures. The basic claim here is that *grammar is conceptualization*. Some of the theories that fall within this paradigm are construction grammar, cognitive grammar, and word grammar.

TOP

Categories:

- Grammar
- Cognitive science

This page was last edited on 15 February 2013, at 00:45.

List of authors: https://tools.wmflabs.org/xtools/wikihistory/wh.php?page_title=Cognitive_approaches_to_grammar

Back to main TOC

Contents

Cognitive Rhetoric

Cognitive rhetoric refers to an approach to rhetoric, composition, and pedagogy as well as a method for language and literary studies drawing from, or contributing to, cognitive science.

History

Following the cognitive revolution, cognitive linguists, computer scientists, and cognitive psychologists have borrowed terms from rhetorical and literary criticism. Specifically, metaphor is a fundamental concept throughout cognitive science, particularly for cognitive linguistic models in which meaning-making is dependent on metaphor production and comprehension.

Computer scientists and philosophers of mind draw on literary studies for terms like “scripts”, “stories”, “stream of consciousness”, “multiple drafts”, and “Joycean machine”. Cognitive psychologists have researched literary and rhetorical topics such as “reader response” and “ deixis” in narrative fiction, and transmission of poetry in oral traditions.

TOC Previous Next

Composition

Rhetoric is a term often used in reference to composition studies and pedagogy, a tradition that dates back to Ancient Greece. The emergence of Rhetoric as a teachable craft (*techne*) links rhetoric and composition pedagogy, notably in the tradition of Sophism. Aristotle collected Sophist handbooks on rhetoric and critiqued them in *Synagoge Techne* (fourth century BCE).

In Ancient Rome, the Greek Rhetorical tradition was absorbed and became vital to education, as rhetoric was valued in a highly political society with an advanced system of law, where speaking well was crucial to winning favor, alliances, and legal rulings.

Cognitive Rhetoricians focusing on composition (such as Linda Flower and John Hayes) draw from the paradigm, methods, and terms of cognitive science to build a pedagogy of composition, where writing is an instance of everyday problem-solving processes.

James A. Berlin has argued that by focusing on professional composition and communications and ignoring ideology, social-cognitive rhetoric—which maps structures of the mind onto structures of language and the interpersonal world—lends itself to use as a tool for training workers in corporate capitalism. Berlin contrasts Social-Cognitive Rhetoric with Social-Epistemic Rhetoric, which makes ideology the core issue of composition pedagogy.

Language and literary studies

Cognitive Rhetoric offers a new way of looking at properties of literature from the perspective of cognitive science. It is interdisciplinary in character and committed to data and methods that produce falsifiable theory. Rhetoric also offers a store of stylistic devices observed for their effect on audiences, providing a rich index with distinguished examples available to researchers in cognitive neuropsychology and cognitive science.

For Mark Turner (a prominent figure in Cognitive Rhetoric), narrative imaging is the fundamental instrument of everyday thought. Individuals organize experience in a constant narrative flow, starting with small spatial stories. Meaning is fundamentally parabolic (like a parable): two or more event shapes or conceptual spaces converge (blending) in the parabolic process, generating concepts with unique properties not found in either of the inputs. This process is everyday: anticipating that an object you are headed toward will make contact with you is a parable whereby you project a spatial viewpoint. Such narrative flow is a highly adaptive process, crucial for planning, evaluating, explaining, as well as recalling the past and imagining a future. Thus, literary processes have adaptive value prior to the emergence of linguistic capability (modular or continuous).

Related work

- Rhetorical stylistics
- Rhetorical figures
- Perception
- Brain imaging

TOC Previous Next

Key terms

- Cognitive instability
- Conceptual blending
- Conceptual metaphor
- Binding
- Projection

Notable researchers

See also

- Cognitive poetics
- Cognitive philology
- Cognitive science
- Cognitive linguistics
- Cognitive neuropsychology
- Cognitive historicism

References

Cognitive rhetoric

- Fahnestock, Jeanne. “Rhetoric in the Age of Cognitive Science”. *The Viability of Rhetoric*. Graff, Richard. ed. New York: State University of New York Press, 2005.
- Gibbs, Raymond. *The Poetics of Mind: Figurative Thought, Language, and Understanding*. Cambridge: Cambridge University Press, 1993.
- Lakoff, George. *Women, Fire, and Dangerous Things: What Categories Reveal about the Mind*. Chicago: University of Chicago Press, 1987.
- Lakoff, George, and Mark Turner. *More than Cool Reason: A Field Guide to Poetic Metaphor*. Chicago: University of Chicago Press, 1989.
- Lakoff, George. “The Contemporary Theory of Metaphor.” In *Metaphor and Thought*, 2nd ed. Ed. Andrew Ortony. Cambridge: Cambridge University Press, 1993.
- Jackson, Tony. “Questioning Interdisciplinarity: Cognitive Science, Evolutionary Psychology, and Literary Criticism”. *Poetics Today*, 21: 319-47.
- Jackson, Tony. “Issues and Problems in the Blending of Cognitive Science, Evolutionary Psychology, and Literary Study.” *Poetics Today*, 23.1 (2002) 161-179.
- Johnson, Mark. *The Body in the Mind: The Bodily Basis of Meaning, Imagination and Reason*. Chicago: University of Chicago Press, 1987.
- Oakley, Todd. "From Attention to Meaning: Explorations in Semiotics, Linguistics, and Rhetoric." European Semiotics Series, Volume 8. Lang Verlag, 2009.
- Parrish, Alex C. *Adaptive Rhetoric: Evolution, Culture, and the Art of Persuasion*. New York: Routledge, 2013.
- Pinker, Stephen. *Words and Rules: The Ingredients of Language*. New York: Basic Books, 1999.

- Richardson, Alan. “Literature and the Cognitive Revolution: An Introduction.” *Poetics Today*, 23.1 (2002) 1-8.
- Shen, Yeshayahu. “Cognitive Aspects of Metaphor”. *Poetics Today*, 13.4: 567-74.
- Tomascello, Michael. “Language Is Not an Instinct.” *Cognitive Development*, 10 (1995): 131-56.
- Turner, Mark. *Death is the Mother of Beauty: Mind, Metaphor, and Criticism*. Chicago: University of Chicago Press, 1987
- Turner, Mark. *Reading Minds: The Study of English in the Age of Cognitive Science*. Princeton: Princeton University Press, 1991.

Cognitive rhetoric, composition, and pedagogy

- Berlin, James. “Rhetoric and Ideology in the Writing Class”. *College English*, 50.5 September 1988: 477-494.
- Bruner, Jerome S. *The Process of Education*. Cambridge: Harvard University Press, 1960.
- Bruner, Jerome S., R.R.Oliver and P.M. Greenfield et al. *Studies in Cognitive Growth*. New York: John Wiley, 1967.
- Christensen, Francis. *Notes Toward a New Rhetoric: Six Essays for Teachers*. New York: Harper and Row, 1967.
- Flower, Linda. *The Construction of Negotiated Meaning: A Social Cognitive Theory of Writing*. Carbondale and Edwardsvill: Southern Illinois University Press, 1994.
- Flower, Linda and John R. Hayes. “A Cognitive Process Theory of Writing.” *College Composition and Communications*, 32 (1981): 365-87.
- Flower, Linda. *Problem-Solving Strategies for Writing*. 2nd Ed. San Diego: Harcourt, 1985.
- Hayes, John R. and Linda Flower. “Cognitive Processes in Revision.” In Rosenberg (ed.), *Advances In Applied Psycholinguistics*. New York: Cambridge University Press, 1987.
- Shor, Ira. *Critical Teaching and Everyday Life*. Chicago: University of Chicago Press, 1987.
- Tsur, Reuven. “The Place of Nonconceptual Information in University Education with Special Reference to Teaching Literature”.

Pragmatics & Cognition, 17 (2009): 309–330.
- Tsur, Reuven. *Toward a Theory of Cognitive Poetics*. Amsterdam: North-Holland. 1992.

External links

Cognitive Rhetoric

- Mark Turner's homepage
- Reuven Tsur's homepage
- Tim Roher's Annotated Bibliography of Metaphor and Cognitive Science

Cognitive Rhetoric, Composition, and Pedagogy

- Linda Flower's homepage

Categories:

- Rhetoric
- Cognitive science

This page was last edited on 10 August 2017, at 07:26.

Back to main TOC

Contents

Scientific Consensus

Jump to navigation Jump to search

Scientific consensus is the collective judgment, position, and opinion of the community of scientists in a particular field of study. Consensus implies general agreement, though not necessarily unanimity.[1]

Consensus is normally achieved through communication at conferences, the publication process, replication (reproducible results by others), and peer review. These lead to a situation in which those within the discipline can often recognize such a consensus where it exists, but communicating to outsiders that consensus has been reached can be difficult, because the 'normal' debates through which science progresses may seem to outsiders as contestation.[2](subscription required) On occasion, scientific institutes issue position statements intended to communicate a summary of the science from the "inside" to the "outside" of the scientific community. In cases where there is little controversy regarding the subject under study, establishing what the consensus is can be quite straightforward.

Scientific consensus may be invoked in popular or political debate on subjects that are controversial within the public sphere but which may not be controversial within the scientific community, such as evolution[3][4] or the lack of a link between MMR vaccinations and autism.[2]

TOP

TOC Next

Change of consensus over time

See also: Theories and sociology of the history of science

There are many philosophical and historical theories as to how scientific consensus changes over time. Because the history of scientific change is extremely complicated, and because there is a tendency to project "winners" and "losers" onto the past in relation to our *current* scientific consensus, it is very difficult to come up with accurate and rigorous models for scientific change.[5] This is made exceedingly difficult also in part because each of the various branches of science functions in somewhat different ways with different forms of evidence and experimental approaches.[*citation needed*]

Most models of scientific change rely on new data produced by scientific experiment. Karl Popper proposed that since no amount of experiments could ever *prove* a scientific theory, but a single experiment could *disprove* one, science should be based on falsification.[6] Whilst this forms a logical theory for science, it is in a sense "timeless" and does not necessarily reflect a view on how science should progress over time.

Among the most influential challengers of this approach was Thomas Kuhn, who argued instead that experimental data always provide some data which cannot fit completely into a theory, and that falsification alone did not result in scientific change or an undermining of scientific consensus. He proposed that scientific consensus worked in the form of "paradigms", which were interconnected theories and underlying assumptions about the nature of the theory itself which connected various researchers in a given field. Kuhn argued that only after the accumulation of many "significant" anomalies would scientific consensus enter a period of "crisis". At this point, new theories would be sought out, and eventually one paradigm would triumph over the old one – a series of paradigm shifts rather than a linear progression towards truth. Kuhn's model also emphasized more clearly the social and personal aspects of theory change, demonstrating through historical examples that scientific consensus was

never truly a matter of pure logic or pure facts.[7] However, these periods of 'normal' and 'crisis' science are not mutually exclusive. Research shows that these are different modes of practice, more than different historical periods.[2]

TOC | Previous | Next

Perception and public opinion

Perception of whether a scientific consensus exists on a given issue, and how strong that conception is, has been described as a "gateway belief" upon which other beliefs and then action are based.[8]

Politicization of science

Main article: Politicization of science

In public policy debates, the assertion that there exists a consensus of scientists in a particular field is often used as an argument for the validity of a theory and as support for a course of action by those who stand to gain from a policy based on that consensus. Similarly arguments for a *lack* of scientific consensus are often encouraged by sides who stand to gain from a more ambiguous policy.[*citation needed*]

For example, the scientific consensus on the causes of global warming is that global surface temperatures have increased in recent decades and that the trend is caused primarily by human-induced emissions of greenhouse gases.[9][10][11] The historian of science Naomi Oreskes published an article in *Science* reporting that a survey of the abstracts of 928 science articles published between 1993 and 2003 showed none which disagreed explicitly with the notion of anthropogenic global warming.[12] In an editorial published in *The Washington Post*, Oreskes stated that those who opposed these scientific findings are amplifying the normal range of scientific uncertainty about any facts into an appearance that there is a great scientific disagreement, or a lack of scientific consensus.[13] Oreskes's findings were replicated by other methods that require no interpretation.[2]

The theory of evolution through natural selection is also supported by an overwhelming scientific consensus; it is one of the most reliable and empirically tested theories in science.[14][15] Opponents of evolution claim that there is significant dissent on evolution within the scientific community.[16] The wedge strategy, a plan to promote intelligent design, depended greatly on seeding and building on public perceptions of absence of consensus on evolution.[17]

The inherent uncertainty in science, where theories are never *proven* but can only be *disproven* (see falsifiability), poses a problem for

politicians, policymakers, lawyers, and business professionals. Where scientific or philosophical questions can often languish in uncertainty for decades within their disciplinary settings, policymakers are faced with the problems of making sound decisions based on the currently available data, even if it is likely not a final form of the "truth". The tricky part is discerning what is close enough to "final truth". For example, social action against smoking probably came too long after science was 'pretty consensual'.[2]

Certain domains, such as the approval of certain technologies for public consumption, can have vast and far-reaching political, economic, and human effects should things run awry with the predictions of scientists. However, insofar as there is an expectation that policy in a given field reflect knowable and pertinent data and well-accepted models of the relationships between observable phenomena, there is little good alternative for policy makers than to rely on so much of what may fairly be called 'the scientific consensus' in guiding policy design and implementation, at least in circumstances where the need for policy intervention is compelling. While science cannot supply 'absolute truth' (or even its complement 'absolute error') its utility is bound up with the capacity to guide policy in the direction of increased public good and away from public harm. Seen in this way, the demand that policy rely only on what is proven to be "scientific truth" would be a prescription for policy paralysis and amount in practice to advocacy of acceptance of all of the quantified and unquantified costs and risks associated with policy inaction.[2]

No part of policy formation on the basis of the ostensible scientific consensus precludes persistent review either of the relevant scientific consensus or the tangible results of policy. Indeed, the same reasons that drove reliance upon the consensus drives the continued evaluation of this reliance over time – and adjusting policy as needed.[*citation needed*]

TOC Previous Next

See also

- Appeal to authority
- Consensus reality
- CUDOS
- Fringe theory
- Medical consensus
- Paradigm
- Status quaestionis

Notes

1. ^ *"Scientific Consensus". Green Facts. Retrieved October 24, 2016.*
2. ^ a b c d e f *Shwed Uri; Peter Bearman (December 2010). "The Temporal Structure of Scientific Consensus Formation". American Sociological Review.* ***75*** *(6): 817–40. doi:10.1177/0003122410388488. PMC 3163460 . Retrieved 18 December 2010.*
3. ^ *"Statement on the Teaching of Evolution" (PDF). American Association for the Advancement of Science. 2006-02-16. Retrieved 2008-05-02.*
4. ^ *"NSTA Position Statement: The Teaching of Evolution". National Science Teacher Association. Retrieved 2008-05-02.*
5. ^ *Pickering, Andrew (1995). The Mangle of Practice. IL: Chicago University Press. ISBN 0-226-66802-9.*
6. ^ *Popper, Karl Raimund (1934). The Logic of Scientific Discovery (2002 ed.). New York: Routledge Classics. ISBN 978-0-415-27844-7.* Originally published in German as *Logik der Forschung: zur Erkenntnistheorie der modenen Naturwissenschaft. Schriften zur Wissenschaftlichen Weltauffassung. Vienna: Springer. 1935. OCLC 220936200.*
7. ^ *Kuhn, Thomas S. (1962). The Structure of Scientific Revolutions (1996 ed.). University of Chicago Press, Chicago. ISBN 978-0-226-45808-3.*
8. ^ *"Scientists are from Mars, Laypeople are from Venus: An Evidence-Based Rationale for Communicating the Consensus on Climate". Reports of the National Center for Science Education.* ***34*** *(6). November–December 2014.*
9. ^ *Oreskes, Naomi (December 2004). "Beyond the Ivory Tower: The Scientific Consensus on Climate Change". Science.* ***306*** *(5702): 1686. doi:10.1126/science.1103618. PMID 15576594.*
10. ^ *America's Climate Choices: Panel on Advancing the Science of Climate Change; National Research Council (2010). Advancing the Science of Climate Change. Washington, D.C.: The National*

Academies Press. ISBN 0-309-14588-0.
11. ^ *"Understanding and Responding to Climate Change"* *(PDF). United States National Academy of Sciences. 2008. Retrieved 30 May 2010.*
12. ^ Naomi Oreskes, "The Scientific Consensus on Climate Change." *Science* 306:5702 (3 December 2004): p. 1686. Accessed 7 July 2006.
13. ^ Naomi Oreskes, "Undeniable Global Warming." *The Washington Post* (26 December 2004): B07.
14. ^ *National Academy of Science Institute of Medicine (2008). Science, Evolution, and Creationism. National Academy Press. ISBN 0-309-10586-2.*
15. ^ "That this controversy is one largely manufactured by the proponents of creationism and intelligent design may not matter, and as long as the controversy is taught in classes on current affairs, politics, or religion, and not in science classes, neither scientists nor citizens should be concerned." Intelligent Judging – Evolution in the Classroom and the Courtroom George J. Annas, New England Journal of Medicine, Volume 354:2277–81 May 25, 2006
16. ^ Stephen Jay Gould, "Evolution as Fact and Theory," May 1981; in *Hen's Teeth and Horse's Toes.* New York: W. W. Norton & Company, 1994: 253–62.
17. ^ "The Wedge Document" Discovery Institute, 1999.

Categories:

- Heuristics
- Philosophy of science
- Consensus

This page was last edited on 16 May 2018, at 08:16.

Back to main TOC

Contents

Cue Validity

Cue validity is the conditional probability that an object falls in a particular category given a particular feature or *cue*. The term was popularized by Beach (1964), Reed (1972) and especially by Eleanor Rosch in her investigations of the acquisition of so-called *basic categories* (Rosch & Mervis 1975;Rosch 1978).

Definition of cue validity

Formally, the cue validity of a feature with respect to category has been defined in the following ways:

- As the conditional probability ; see Reed (1972), Rosch & Mervis (1975), Rosch (1978).
- As the deviation of the conditional probability from the category base rate, ; see Edgell (1993), Kruschke & Johansen (1999).
- As a function of the linear correlation; see Smedslund (1955), Castellan (1973), Sawyer (1991), Busemeyer, Myung & McDaniel (1993).
- Other definitions; see Restle (1957), Martignon et al. (2003).

For the definitions based on probability, a high cue validity for a given feature means that the feature or attribute is more diagnostic of the class membership than a feature with low cue validity. Thus, a high-cue validity feature is one which conveys more information about the category or class variable, and may thus be considered as more useful for identifying objects as belonging to that category. Thus, high cue validity expresses high feature *informativeness*. For the definitions based on linear correlation, the expression of "informativeness" captured by the cue validity measure is not the full expression of the feature's informativeness (as in mutual information, for example), but only that portion of its informativeness that is expressed in a linear relationship. For some purposes, a bilateral measure such as the mutual information or category utility is more appropriate than the cue validity.

Examples

As an example, let us consider the domain of "numbers" and allow that every number has an attribute (i.e., a *cue*) named "`is_positive_integer`", which we call , and which adopts the value 1 if the number is actually a positive integer. Then we can inquire what the validity of this cue is with regard to the following classes: {`rational number`, `irrational number`, `even integer`}:

- If we know that a number is a positive integer we know that it is a rational number. Thus, , the cue validity for `is_positive_integer` as a cue for the category `rational number` is 1.
- If we know that a number is a positive integer then we know that it is *not* an irrational number. Thus, , the cue validity for `is_positive_integer` as a cue for the category `irrational number` is 0.
- If we know only that a number is a positive integer, then its chances of being even or odd are 50-50 (there being the same number of even and odd integers). Thus, , the cue validity for `is_positive_integer` as a cue for the category `even integer` is 0.5, meaning that the attribute `is_positive_integer` is entirely uninformative about the number's membership in the class `even integer`.

In perception, "cue validity" is often short for *ecological validity* of a perceptual cue, and is defined as a correlation rather than a probability (see above). In this definition, an uninformative perceptual cue has an ecological validity of 0 rather than 0.5.

TOC Previous Next

Use of the cue validity

In much of the work on modeling human category learning, there has been the assumption made (and sometimes validated) that attentional weighting tracks the cue validity, or tracks some related measure of feature informativeness. This would imply that attributes are differently weighted by the perceptual system; informative or high-cue validity attributes being weighted more heavily, while uninformative or low-cue validity attributes are weighted more lightly or ignored altogether (see, e.g., Navarro 1998).

TOC Previous

References

- *Beach, Lee Roy (1964), "Cue probabilism and inference behavior", Psychological Monographs: General and Applied,* ***78*** *(5): 1–20, doi: 10.1037/h0093853*
- *Busemeyer, Jerome R.; Myung, In Jae; McDaniel, Mark A. (1993), "Cue competition effects: Empirical tests of adaptive network learning models", Psychological Science,* ***4*** *(3): 190–195, doi: 10.1111/j.1467-9280.1993.tb00486.x*
- *Castellan, N. John (1973), "Multiple-cue probability learning with irrelevant cues", Organizational Behavior and Human Performance,* ***9*** *(1): 16–29, doi: 10.1016/0030-5073(73)90033-0*
- *Edgell, Stephen E. (1993), "Using configural and dimensional information", in N. John Castellan, Individual and Group Decision Making: Current Issues, Hillsdale, New Jersey: Lawrence Erlbaum, pp. 43–64*
- *Kruschke, John K.; Johansen, Mark K. (1999), "A model of probabilistic category learning", Journal of Experimental Psychology: Learning, Memory, and Cognition,* ***25*** *(5): 1083–1119, doi: 10.1037/0278-7393.25.5.1083*
- *Martignon, Laura; Vitouch, Oliver; Takezawa, Masanori; Forster, Malcolm R. (2003), "Naive and yet enlightened: From natural frequencies to fast and frugal decision trees", in David Hardman & Laura Macchi, Thinking: Psychological Perspectives on Reasoning, Judgment and Decision Making, New York: John Wiley & Sons, pp. 190–211*
- *Reed, Stephen K. (1972), "Pattern recognition and categorization", Cognitive Psychology,* ***3*** *(3): 382–407, doi: 10.1016/0010-0285(72)90014-x*
- *Restle, Frank (1957), "Theory of selective learning with probable reinforcements", Psychological Review,* ***64*** *(3): 182–191, doi: 10.1037/h0042600*
- *Rosch, Eleanor (1978), "Principles of categorization", in Eleanor Rosch & Barbara B. Lloyd, Cognition and Categorization, Hillsdale, New Jersey: Lawrence Erlbaum, pp. 27–48*

- *Rosch, Eleanor; Mervis, Carolyn B. (1975), "Family Resemblances: Studies in the Internal Structure of Categories", Cognitive Psychology, **7** (4): 573–605, doi: 10.1016/0010-0285(75)90024-9*
- *Sawyer, John E. (1991), "Hypothesis sampling, construction, or adjustment: How are inferences about nonlinear monotonic contingencies developed", Organizational Behavior and Human Decision Processes, **49**: 124–150, doi: 10.1016/0749-5978(91)90045-u*
- *Smedslund, Jan (1955), Multiple-Probability Learning: An Inquiry into the Origins of Perception, Oslo: Akademisk Forlag*

Categories:

- Conditional probability
- Cognitive science
- Cognition

This page was last edited on 9 December 2016, at 16:02.

Back to main TOC

Mental World

Jump to navigation Jump to search

The **mental world** is an ontological category in metaphysics, populated by nonmaterial mental objects, without physical extension (though possibly with mental extension as in a visual field, or possibly not, as in an olfactory field) contrasted with the physical world of space and time populated with physical objects, or Plato's world of ideals populated, in part, with mathematical objects.[1][2][3][4][5]

The mental world may be populated with, or framed with, intentions, sensory fields, and corresponding objects.

The mental world is usually considered to be subjective and not objective.

In psychologism, mathematical objects are mental objects.

Descartes argued for a mental world as separate from the physical world.[6] Debates regarding free will include how it could be possible for anything in the mental world to have an effect on the physical world. In various forms of Epiphenomenalism, the physical world can cause effects in the mental world, but not conversely.[3][6] Behaviorists deny that a mental world can be meaningfully referred to.[7]

Reasoning laws about a mental world are different than the ones for a physical world. In particular, individuals with autism experience substantial difficulties in the former but perform relatively well in the latter.[8]

References

1. ^ Synopsis of *Consciousness and Berkeley's Metaphysics*. ... "What are the basic constituents of the mental world?", *Consciousness and Berkley's Metaphysics*, Peter B. Lloyd, 2008
2. ^ Gottlob Frege, *Foundations of Arithmetic*
3. ^ *a* *b* Metaphysics, Richard Taylor, *Foundations of Philosophy* series
4. ^ *Problems of Philosophy*, Bertrand Russell
5. ^ *History of Western Philosophy*, Bertrand Russell
6. ^ *a* *b* *Meditations*, Renes Descartes
7. ^ *Beyond Freedom and Dignity*, B. F. Skinner
8. ^ Galitsky, B., 2013 "A computational simulation tool for training autistic reasoning about mental attitudes", Knowledge-Based Systems, 50:25-43

See also

- Mind-body dualism
- Mind-body problem
- Descartes
- Berkeley
- Behaviorism
- Mental operations

TOP

Categories:

- Philosophy of mind
- Ontology
- Cognitive science

This page was last edited on 4 March 2018, at 08:40.

Contents

Associative group Analysis

Jump to navigation Jump to search

Associative Group Analysis (AGA) is an inferential approach to analyze people's mental representations, focusing on subjective meanings and images to assess similarities and differences across cultures and belief systems. Culture can be regarded as "a group-specific cognitive organization or world view composed of the mosaic elements of meanings [1]". A language, as a communication tool in daily life, contains culturally specific meanings for people who use it. The words people use reflect not only their cognitions, but also their affections and behavioral intentions. To understand differences in psychological meaning across cultures, it is useful to analyze words in a language. The words people use reflect their thinking or feeling. Thinking, or more precisely the cognitive process, together with feeling, guides most of human behavior. By using AGA, we are able to understand how different groups organize and integrate their perceptions and understandings of the world around them.

AGA assumes a close relationship between people's subjective understandings and their behavior. The verbal associations are determined largely by a decoding of meaning reaction. The disposition of associations then guides the overt reaction. AGA defines the stimulus word as the unit of analysis (rather than individuals, groups, or society, etc.) and as the key unit in the perceptual representational system. By analyzing free verbal associations, researchers can determine the vertical and horizontal structure of the belief system.

TOP

TOC Next

Perceptual Representational System

The perceptual representational system includes what people perceive and think about an issue, object, behavior, etc. It is an inclusive worldview, composed of interdependent, representational units. There are three characteristics central to the perceptual-representational system.

TOC Next

Hierarchy of priorities

Among the representational units, some are more salient or dominant than others. For example, "Free market" is more salient to capitalistic countries than to communist countries.

TOC Previous Next

Relatedness or affinity

Some units cluster into a larger category, sharing similar meanings and thus increasing the strength of selected views and beliefs. For example, the theme "Self" to some groups denotes individual self since people might associate this word with "Me," "Individual," "Esteem," "Person," etc. However, for other groups of people, the concept of self is a social self. They associate it with "Society," "Family," "Responsibility," etc. These clusters identify the culture, beliefs, and assumptions that can help us predict areas of motivation, vulnerability, need and concern within the group.

TOC Previous Next

Affect loading

The representational units are tinted with emotions, feelings and evaluations. E.g., "Marijuana" may convey negative images like "hell" or "illegal" for some groups of people where its usage is illegal, but neutral meanings for others.

From the above three characteristics, the AGA method focuses on three main categories of information:

1. The meaning composition of selected themes.
2. The dominance of themes (i.e., the relative positions in a vertical dimension of priorities).
3. The relationship among themes and among their natural clusters (i.e., the horizontal patterns of affinities)

Sampling

AGA is not used as a survey instrument. It is a sociological approach, with the primary goal of assessing people's subjective representation of their experiences as conveyed by their priorities, perceptions, and meanings. Therefore, the AGA approach is closer to anthropological strategies that intensively assess culturally representative small groups rather than to strategies that use carefully organized large samples. Since statistical significance is not the primary concern, a sample of 50 to 100 respondents is sufficient. However, if the group is quite heterogeneous with considerable variation among subjects, a larger number of subjects is needed ([2]).

TOC | Previous | Next

Data Collection Procedure

Subjects are given a card with stimulus word (theme) in their native language. Each card lists one theme on multiple lines and includes space for writing down subjects' free associations to the stimulus word. Cards are given in a random order and subjects are told to give any response that occurred to them in the context of the theme within one minute. After one minute, another card is given. To conduct a reasonably comprehensive study, 50 to 100 themes should be presented. For an in-depth study, 100 to 200 systematically selected themes are required.

After collecting data, scores are assigned to responses to indicate the relative importance of that response to the theme's psychological meaning. The weights are assigned to each response according to the proximity of the response to the stimulus word, in a consecutive order of 6, 5, 4, 3, 3, 3, 3, 2, 2, 1, 1……

The group responses contain a rich source of culturally-specific information. The dominant mindset is the group's most salient themes configured with their themes of closest affinity, presented by semantographs.

TOC | Previous | Next

Semantograph

Differences in meaning of individual themes can be shown by using semantographs. Figure 2 shows how Russian and American managers associate the theme “Freedom.” American associations are indicated in blue, and the Russian associations are indicated in red. The vertical axis contains the associated words for the two groups, and the horizontal axis represents the weighted score for each associated word.

Application

The characteristics of the AGA method make it well suited for research on cultural/belief change and comparative studies of cultural differences among national groups. Kelly [3] used AGA in a curriculum study. In a curriculum development project called “Justice and the City,” to evaluate whether the concept of justice is learnt by students from the curriculum project, 41 themes grouped into four basic domains (Basic Values, Means/End, Analytical Units, and Political-Economic Orientation domains) were given to students. A content analysis of the responses to the stimulus word “justice,” revealed that the meaning of justice was substantially changed in the experiment. Students in all urban affairs/public policy classes listed specific kinds of justice (e.g., religious, corporate, natural, liberal, Marxist) and public policy issues in the cards while these responses did not appear in the pretest.

Another AGA study was used in assessing the cultural adaption of Filipinos who had been in the U.S. Navy. Three groups of Filipinos were compared to similarly composed groups of Americans: those who were newly recruited to the U.S. Navy, those who had been in the Navy between 1 and 10 years, and those who had been in the Navy from 11 to 25 years. The results indicated that cultural adaptation occurred most in domains such as “Work” and “Service.” Cultural adaptation occurred least in domains such as “Family,” “Friends,” “Society,” “Interpersonal Relations,” and “Religion.” These domains are most influenced by tradition and early socialization. This study also revealed that cultural adaption is also a function of time spent in the host environment. The change from the first group (new recruits) to the second group (those who had been in the Navy 1–10 years) is faster than the change from the second group to the third group (those who had been in the Navy 11–25 years).

Limitation

(1) The method's authors do not offer a measure of significance. (2) This method reveals the power, density, and constraints of a theme,[4] but the interpretation of a word might be context dependent. For example, Russians associated "innovation" with "change," but we don't know the change is interpreted as negative or positive.

TOC Previous

References

1. ^ 2. Szalay, L. B., Maday, B. C., Blacking, J., Bock, B., Fischer, J. L., Frisch, J. A., Healey, A., Hoppal, M., Laosa, L. M., Swartz, J. D., Maranda, P., Powesland, P. F., Voight, V. (1973) “Verbal associations in the analysis of subjective culture [and comments and reply],” Current Anthropology, 14 (1/2), pp. 33-50.
2. ^ Szalay, L. B. and Kelly, R. M. (1982) “Political ideology and subjective culture: Conceptualization and empirical assessment,” the American Political Science Review, 76 (3), pp. 585-602.
3. ^ Kelly, R. M. (1985) “the Associative group analysis method and evaluation research,” Evaluation Review, 9 (35), pp. 35-50.
4. ^ Bovasso, G., Scalay, L. Boase, V., and Stanford, M. (1993) “A graph theory model of the semantic structure of attitudes,” journal of Psycholinguistic Research, 22, pp. 411-425.

Categories:

- Cognitive science
- Cultural anthropology

This page was last edited on 23 October 2017, at 12:15.

Contents

Physical symbol System

Jump to navigation Jump to search
See also: Philosophy of artificial intelligence and Data system

A **physical symbol system** (also called a formal system) takes physical patterns (symbols), combining them into structures (expressions) and manipulating them (using processes) to produce new expressions.

The **physical symbol system hypothesis** (**PSSH**) is a position in the philosophy of artificial intelligence formulated by Allen Newell and Herbert A. Simon. They wrote:

This claim implies both that human thinking is a kind of symbol manipulation (because a symbol system is necessary for intelligence) and that machines can be intelligent (because a symbol system is sufficient for intelligence).[2]

The idea has philosophical roots in Hobbes (who claimed reasoning was "nothing more than reckoning"), Leibniz (who attempted to create a logical calculus of all human ideas), Hume (who thought perception could be reduced to "atomic impressions") and even Kant (who analyzed all experience as controlled by formal rules).[3] The latest version is called the computational theory of mind, associated with philosophers Hilary Putnam and Jerry Fodor.[4]

The hypothesis has been criticized strongly by various parties, but is a core part of AI research. A common critical view is that the hypothesis seems appropriate for higher-level intelligence such as playing chess, but less appropriate for commonplace intelligence such as vision. A distinction is usually made between the kind of high level symbols that directly correspond with objects in the world, such as <dog> and <tail> and the more complex "symbols" that are present in a machine like a neural network.

Examples

Examples of physical symbol systems include:

- Formal logic: the symbols are words like "and", "or", "not", "for all x" and so on. The expressions are statements in formal logic which can be true or false. The processes are the rules of logical deduction.
- Algebra: the symbols are "+", "×", "*x*", "*y*", "1", "2", "3", etc. The expressions are equations. The processes are the rules of algebra, that allow one to manipulate a mathematical expression and retain its truth.
- A digital computer: the symbols are zeros and ones of computer memory, the processes are the operations of the CPU that change memory.
- Chess: the symbols are the pieces, the processes are the legal chess moves, the expressions are the positions of all the pieces on the board.

The physical symbol system hypothesis claims that both of these are also examples of physical symbol systems:

- Intelligent human thought: the symbols are encoded in our brains. The expressions are thoughts. The processes are the mental operations of thinking.
- A running artificial intelligence program: The symbols are data. The expressions are more data. The processes are programs that manipulate the data.

TOC Previous Next

Arguments in favor of the physical symbol system hypothesis

TOC Previous Next

Newell and Simon

Two lines of evidence suggested to Allen Newell and Herbert A. Simon that "symbol manipulation" was the essence of both human and machine intelligence: the development of artificial intelligence programs and psychological experiments on human beings.

First, in the early decades of AI research there were a number of very successful programs that used high level symbol processing, such as Newell and Herbert A. Simon's General Problem Solver or Terry Winograd's SHRDLU.[5] John Haugeland named this kind of AI research "Good Old Fashioned AI" or GOFAI.[6] Expert systems and logic programming are descendants of this tradition. The success of these programs suggested that symbol processing systems could simulate any intelligent action.

And second, psychological experiments carried out at the same time found that, for difficult problems in logic, planning or any kind of "puzzle solving", people used this kind of symbol processing as well. AI researchers were able to simulate the step by step problem solving skills of people with computer programs. This collaboration and the issues it raised eventually would lead to the creation of the field of cognitive science.[7] (This type of research was called "cognitive simulation".) This line of research suggested that human problem solving consisted primarily of the manipulation of high level symbols.

TOC Previous Next

Symbols vs. signals

In Newell and Simon's arguments, the "symbols" that the hypothesis is

referring to are physical objects that represent things in the world, symbols such as <dog> that have a recognizable meaning or denotation and can be composed with other symbols to create more complex symbols.

However, it is also possible to interpret the hypothesis as referring to the simple abstract 0s and 1s in the memory of a digital computer or the stream of 0s and 1s passing through the perceptual apparatus of a robot. These are, in some sense, symbols as well, although it is not always possible to determine exactly what the symbols are standing for. In this version of the hypothesis, no distinction is being made between "symbols" and "signals", as David Touretzky and Dean Pomerleau explain.[8]

Under this interpretation, the physical symbol system hypothesis asserts merely that intelligence can be *digitized*. This is a weaker claim. Indeed, Touretzky and Pomerleau write that if symbols and signals are the same thing, then "[s]ufficiency is a given, unless one is a dualist or some other sort of mystic, because physical symbol systems are Turing-universal."[8] The widely accepted Church–Turing thesis holds that any Turing-universal system can simulate any conceivable process that can be digitized, given enough time and memory. Since any digital computer is Turing-universal, any digital computer can, in theory, simulate anything that can be digitized to a sufficient level of precision, including the behavior of intelligent organisms. The necessary condition of the physical symbol systems hypothesis can likewise be finessed, since we are willing to accept almost any signal as a form of "symbol" and all intelligent biological systems have signal pathways.

TOC | Previous | Next

Criticism

Nils Nilsson has identified four main "themes" or grounds in which the physical symbol system hypothesis has been attacked.[2]

1. The "erroneous claim that the [physical symbol system hypothesis] lacks symbol grounding" which is presumed to be a requirement for general intelligent action.
2. The common belief that AI requires non-symbolic processing (that which can be supplied by a connectionist architecture for instance).
3. The common statement that the brain is simply not a computer and that "computation as it is currently understood, does not provide an appropriate model for intelligence".
4. And last of all that it is also believed in by some that the brain is essentially mindless, most of what takes place are chemical reactions and that human intelligent behaviour is analogous to the intelligent behaviour displayed for example by ant colonies.

TOC Previous Next

Dreyfus and the primacy of unconscious skills

Main article: Dreyfus' critique of artificial intelligence

Hubert Dreyfus attacked the necessary condition of the physical symbol system hypothesis, calling it "the psychological assumption" and defining it thus:

- *The mind can be viewed as a device operating on bits of information according to formal rules.*[9]

Dreyfus refuted this by showing that human intelligence and expertise depended primarily on unconscious instincts rather than conscious symbolic manipulation. Experts solve problems quickly by using their intuitions, rather than step-by-step trial and error searches. Dreyfus argued that these unconscious skills would never be captured in formal rules.[10]

Searle and his Chinese room

Main article: Chinese room

John Searle's Chinese room argument, presented in 1980, attempted to show that a program (or any physical symbol system) could not be said to "understand" the symbols that it uses; that the symbols themselves have no meaning or semantic content, and so the machine can never be truly intelligent from symbol manipulation alone. [11]

Brooks and the roboticists

Main articles: Artificial intelligence, situated approach and Moravec's paradox

In the sixties and seventies, several laboratories attempted to build robots that used symbols to represent the world and plan actions (such as the Stanford Cart). These projects had limited success. In the middle eighties, Rodney Brooks of MIT was able to build robots that had superior ability to move and survive without the use of symbolic reasoning at all. Brooks (and others, such as Hans Moravec) discovered that our most basic skills of motion, survival, perception, balance and so on did not seem to require high level symbols at all, that in fact, the use of high level symbols was more complicated and less successful.

In a 1990 paper Elephants Don't Play Chess, robotics researcher Rodney Brooks took direct aim at the physical symbol system hypothesis, arguing that symbols are not always necessary since "the world is its own best model. It is always exactly up to date. It always has every detail there is to be known. The trick is to sense it appropriately and often enough."[12]

Connectionism

Main article: Connectionism

Embodied philosophy

Main article: Embodied philosophy

George Lakoff, Mark Turner and others have argued that our abstract skills in areas such as mathematics, ethics and philosophy depend on unconscious skills that derive from the body, and that conscious symbol manipulation is only a small part of our intelligence.

See also

- Artificial intelligence, situated approach

TOC Previous Next

Notes

1. ^ Newell & Simon 1976, p. 116 and Russell & Norvig 2003, p. 18
2. ^ a b Nilsson 2007, p. 1
3. ^ Dreyfus 1979, p. 156, Haugeland, pp. 15–44
4. ^ Horst 2005
5. ^ Dreyfus 1979, pp. 130–148
6. ^ Haugeland 1985, p. 112
7. ^ Dreyfus 1979, pp. 91–129, 170–174
8. ^ a b Reconstructing Physical Symbol Systems David S. Touretzky and Dean A. Pomerleau Computer Science Department Carnegie Mellon University Cognitive Science 18(2):345–353, 1994. http://www.cs.cmu.edu/~dst/pubs/simon-reply-www.ps.gz
9. ^ Dreyfus 1979, p. 156
10. ^ Dreyfus 1972, Dreyfus 1979, Dreyfus & Dreyfus 1986. See also Russell & Norvig 2003, pp. 950–952, Crevier, 1993 & 120–132 and Hearn 2007, pp. 50–51
11. ^ Searle 1980, Crevier 1993, pp. 269–271
12. ^ Brooks 1990, p. 3

References

- *Brooks, Rodney (1990), "Elephants Don't Play Chess"* (PDF), *Robotics and Autonomous Systems*, **6** *(1–2): 3–15, doi: 10.1016/S0921-8890(05)80025-9, retrieved 2007-08-30*.
- *Cole, David (Fall 2004), "The Chinese Room Argument", in Zalta, Edward N., The Stanford Encyclopedia of Philosophy*.
- *Crevier, Daniel (1993), AI: The Tumultuous Search for Artificial Intelligence, New York, NY: BasicBooks, ISBN 0-465-02997-3*
- *Dreyfus, Hubert (1972), What Computers Can't Do, New York: MIT Press, ISBN 0-06-011082-1*
- *Dreyfus, Hubert (1979), What Computers Still Can't Do, New York: MIT Press*.
- *Dreyfus, Hubert; Dreyfus, Stuart (1986), Mind over Machine: The Power of Human Intuition and Expertise in the Era of the Computer, Oxford, U.K.: Blackwell*
- *Gladwell, Malcolm (2005), Blink: The Power of Thinking Without Thinking, Boston: Little, Brown, ISBN 0-316-17232-4*.
- *Haugeland, John (1985), Artificial Intelligence: The Very Idea, Cambridge, Mass.: MIT Press*.
- *Hobbes (1651), Leviathan*.
- *Horst, Steven (Fall 2005), "The Computational Theory of Mind", in Zalta, Edward N., The Stanford Encyclopedia of Philosophy*.
- *Kurzweil, Ray (2005), The Singularity is Near, New York: Viking Press, ISBN 0-670-03384-7*.
- *McCarthy, John; Minsky, Marvin; Rochester, Nathan; Shannon, Claude (1955), A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence, archived from the original on 2008-09-30*.
- *Newell, Allen; Simon, H. A. (1963), "GPS: A Program that Simulates Human Thought", in Feigenbaum, E.A.; Feldman, J., Computers and Thought, New York: McGraw-Hill*
- *Newell, Allen; Simon, H. A. (1976), "Computer Science as Empirical Inquiry: Symbols and Search", Communications of the*

ACM, **19** (3): 113–126, [doi](): [10.1145/360018.360022]()
- [Nilsson, Nils]() (2007), Lungarella, M., ed., ["50 Years of AI"]() (PDF), *Festschrift, LNAI 4850*, Springer, pp. 9–17
- [Russell, Stuart J.](); [Norvig, Peter]() (2003), [*Artificial Intelligence: A Modern Approach*]() (2nd ed.), Upper Saddle River, New Jersey: Prentice Hall, [ISBN]() [0-13-790395-2]()
- [Searle, John]() (1980), ["Minds, Brains and Programs"]() (PDF), *Behavioral and Brain Sciences*, **3** (3): 417–457, [doi](): [10.1017/S0140525X00005756](), archived from [the original]() (PDF) on 2015-09-23
- [Turing, Alan]() (October 1950), ["Computing machinery and intelligence"](), *Mind*, **LIX** (236): 433–460, [doi](): [10.1093/mind/LIX.236.433](), archived from [the original]() on 2008-07-02

[Categories]():

- [Cognitive science]()
- [Philosophy of artificial intelligence]()
- [Physical systems]()
- [Formal systems]()
- [Cognitive modeling]()

Back to main TOC

Macrocognition

Jump to navigation Jump to search

Macrocognition indicates a descriptive level of cognition performed in natural instead of artificial (laboratory) environments. This term is reported to have been coined by Pietro Cacciabue and Erik Hollnagel in 1995.[1][2] However, it is also reported that the term was used in the 1980s in European Cognitive Systems Engineering research. Possibly the earliest reference is the following, although it does not use the exact term "macrocognition":

The use of the term suggests that there is strong evidence in which naturalistic decision-making and the environments in which they occur are navigated in cognitively different ways than artificial or controlled environments.

Macrocognition is distinguished from microcognition by elements of time-pressure and risk, performance by experts (as opposed to college students or novices), ambiguity of goals and outcomes, and complex and unclear conditions.

References

1. ^ P.C. Cacciabue and E. Hollnagel, "Simulation of Cognition: Applications," Expertise and Technology: Cognition and Human-Computer Cooperation, J.M. Hoc, P.C. Cacciabue, and E. Hollnagel, eds., Lawrence Erlbaum Associates, 1995, pp. 55–73.
2. ^ D.E. Klein, H.A. Klein, and G. Klein, "Macrocognition: Linking Cognitive Psychology and Cognitive Ergonomics," Proc. 5th Int’l Conf. Human Interactions with Complex Systems, Univ. of Illinois at Urbana-Champaign, 2000, pp. 173–177
3. ^ Hollnagel, E. (1981). Cognitive psychology: The European and American approaches. (Unpublished manuscript; pdf version available by request to author.)

See also

- Metacognition
- Naturalistic decision-making
- Foltz, P. W., Bolstad, C. A., Cuevas, H. M., Franzke, M., Rosenstein, M., & Costello, A. M. (in press). Measuring situation awareness through automated communication analysis. To appear in M. Letsky, N. Warner, S. M. Fiore, & C. Smith (Eds.), Macrocognition in teams. Aldershot, England: Ashgate.
- Klein, G., Moon, B. and Hoffman, R.F. (2006b). Making sense of sensemaking Ii: a macrocognitive model. IEEE Intelligent Systems, 21(5), 88-92
- Klein, G., Ross, K. G., Moon, B., Klein, D. E., Hoffman, R. R., Hollnagel, E. (2003). Macrocognition. IEEE Intelligent Systems, 81-85.

Categories:

- Cognitive science

This page was last edited on 26 June 2017, at 06:04.

Back to main TOC

Frame-based Terminology

Jump to navigation Jump to search

Frame-based terminology is a cognitive approach to terminology developed by Pamela Faber and colleagues at the University of Granada. One of its basic premises is that the conceptualization of any specialized domain is goal-oriented, and depends to a certain degree on the task to be accomplished. Since a major problem in modeling any domain is the fact that languages can reflect different conceptualizations and construals, texts as well as specialized knowledge resources are used to extract a set of domain concepts. Language structure is also analyzed to obtain an inventory of conceptual relations to structure these concepts.

As its name implies, frame-based terminology uses certain aspects of frame semantics to structure specialized domains and create non-language-specific representations. Such configurations are the conceptual meaning underlying specialized texts in different languages, and thus facilitate specialized knowledge acquisition.

Frame-based terminology focuses on:

1. conceptual organization;
2. the multidimensional nature of terminological units; and
3. the extraction of semantic and syntactic information through the use of multilingual corpora.

In frame-based terminology, conceptual networks are based on an underlying domain event, which generates templates for the actions and processes that take place in the specialized field as well as the entities that participate in them.

As a result, knowledge extraction is largely text-based. The terminological entries are composed of information from specialized texts as well as specialized language resources. Knowledge is configured and represented

in a dynamic conceptual network that is capable of adapting to new contexts. At the most general level, generic roles of agent, patient, result, and instrument are activated by basic predicate meanings such as make, do, affect, use, become, etc. which structure the basic meanings in specialized texts. From a linguistic perspective, Aktionsart distinctions in texts are based on Van Valin's classification of predicate types. At the more specific levels of the network, the qualia structure of the generative lexicon is used as a basis for the systematic classification and relation of nominal entities.

The methodology of frame-based terminology derives the conceptual system of the domain by means of an integrated top-down and bottom-up approach. The bottom-up approach consists of extracting information from a corpus of texts in various languages, specifically related to the domain. The top-down approach includes the information provided by specialized dictionaries and other reference material, complemented by the help of experts in the field.

In a parallel way, the underlying conceptual framework of a knowledge-domain event is specified. The most generic or base-level categories of a domain are configured in a prototypical domain event or action-environment interface. This provides a template applicable to all levels of information structuring. In this way a structure is obtained which facilitates and enhances knowledge acquisition since the information in term entries is internally as well as externally coherent.

References

1. Faber, Pamela. 2009. The cognitive shift in terminology and specialized translation. MonTI, no. 1: 107–134.
2. Faber, Pamela, Pilar León Araúz, and Juan Antonio Prieto Velasco. 2009. Semantic Relations, Dynamicity, and Terminological Knowledge Bases. Current Issues in Language Studies 1: 1–23.
3. Faber, Pamela, Pilar León Araúz, Juan Antonio Prieto Velasco, and Arianne Reimerink. 2007. Linking Images and Words: the description of specialized concepts. International Journal of Lexicography 20, no. 1: 39–65. doi: 10.1093/ijl/ecl038.
4. Faber, Pamela, Silvia Montero Martínez, María Rosa Castro Prieto, José Senso Ruiz, Juan Antonio Prieto Velasco, Pilar León Araúz, Carlos Márquez Linares, and Miguel Vega Expósito. 2006. Process-oriented terminology management in the domain of Coastal Engineering. Terminology 12, no. 2: 189–213. doi: 10.1075/term.12.2.03fab.
5. Faber, Pamela, Carlos Márquez Linares, and Miguel Vega Expósito. 2005. Framing Terminology: A Process-Oriented Approach. Meta : journal des traducteurs / Meta: Translators’ Journal 50, no. 4.

External links

- LexiCon Research Group (Pamela Faber's Research Group at the University of Granada)
- Frame-Based Terminology (LexiCon Research Group)

TOP

Categories:

- Cognitive science
- Psycholinguistics
- Terminology

This page was last edited on 28 June 2013, at 10:35.

Back to main TOC

Contents

Category Utility

Jump to navigation Jump to search

Category utility is a measure of "category goodness" defined in Gluck & Corter (1985) and Corter & Gluck (1992). It attempts to maximize both the probability that two objects in the same category have attribute values in common, and the probability that objects from different categories have different attribute values. It was intended to supersede more limited measures of category goodness such as "cue validity" (Reed 1972; Rosch & Mervis 1975) and "collocation index" (Jones 1983). It provides a normative information-theoretic measure of the *predictive advantage* gained by the observer who possesses knowledge of the given category structure (i.e., the class labels of instances) over the observer who does *not* possess knowledge of the category structure. In this sense the motivation for the *category utility* measure is similar to the information gain metric used in decision tree learning. In certain presentations, it is also formally equivalent to the mutual information, as discussed below. A review of *category utility* in its probabilistic incarnation, with applications to machine learning, is provided in Witten & Frank (2005, pp. 260–262).

Probability-theoretic definition of Category Utility

The probability-theoretic definition of *category utility* given in Fisher (1987) and Witten & Frank (2005) is as follows:

where is a size- set of -ary features, and is a set of categories. The term designates the marginal probability that feature takes on value , and the term designates the category-conditional probability that feature takes on value *given* that the object in question belongs to category .

The motivation and development of this expression for *category utility*, and the role of the multiplicand as a crude overfitting control, is given in the above sources. Loosely (Fisher 1987), the term is the expected number of attribute values that can be correctly guessed by an observer using a probability-matching strategy together with knowledge of the category labels, while is the expected number of attribute values that can be correctly guessed by an observer the same strategy but without any knowledge of the category labels. Their difference therefore reflects the relative advantage accruing to the observer by having knowledge of the category structure.

Information-theoretic definition of the Category Utility

The information-theoretic definition of *category utility* for a set of entities with size- binary feature set , and a binary category is given in Gluck & Corter (1985) as follows:

where is the prior probability of an entity belonging to the positive category (in the absence of any feature information), is the conditional probability of an entity having feature given that the entity belongs to category , is likewise the conditional probability of an entity having feature given that the entity belongs to category , and is the prior probability of an entity possessing feature (in the absence of any category information).

The intuition behind the above expression is as follows: The term represents the cost (in bits) of optimally encoding (or transmitting) feature information when it known that the objects to be described belong to category . Similarly, the term represents the cost (in bits) of optimally encoding (or transmitting) feature information when it known that the objects to be described belong to category . The sum of these two terms in the brackets is therefore the weighted average of these two costs. The final term, , represents the cost (in bits) of optimally encoding (or transmitting) feature information when no category information is available. The value of the *category utility* will, in the above formulation, be negative (???).

TOC Previous Next

Category Utility and Mutual Information

It is mentioned in Gluck & Corter (1985) and Corter & Gluck (1992) that the category utility is equivalent to the mutual information. Here we provide a simple demonstration of the nature of this equivalence. Let us assume a set of entities each having the same features, i.e., feature set , with each feature variable having cardinality . That is, each feature has the capacity to adopt any of distinct values (which need *not* be ordered; all

variables can be nominal); for the special case these features would be considered *binary*, but more generally, for any , the features are simply *m-ary*. For our purposes, without loss of generality, we can replace feature set with a single aggregate variable that has cardinality , and adopts a unique value corresponding to each feature combination in the Cartesian product . (Ordinality does *not* matter, because the mutual information is not sensitive to ordinality.) In what follows, a term such as or simply refers to the probability with which adopts the particular value . (Using the aggregate feature variable replaces multiple summations, and simplifies the presentation to follow.)

We assume also a single category variable , which has cardinality . This is equivalent to a classification system in which there are non-intersecting categories. In the special case of we have the two-category case discussed above. From the definition of mutual information for discrete variables, the mutual information between the aggregate feature variable and the category variable is given by:

where is the prior probability of feature variable adopting value , is the marginal probability of category variable adopting value , and is the joint probability of variables and simultaneously adopting those respective values. In terms of the conditional probabilities this can be re-written (or defined) as

If we will rewrite the original definition of the category utility from above, with , we have

This equation clearly has the same **form** as the (blue) equation expressing the mutual information between the feature set and the category variable; the difference is that the sum in the *category utility* equation runs over independent binary variables , whereas the sum in the mutual information runs over *values* of the single -ary variable . The two measures are actually equivalent then *only* when the features , are *independent* (and assuming that terms in the sum corresponding to are also added).

TOC | Previous | Next

Insensitivity of category utility to ordinality

Like the mutual information, the *category utility* is not sensitive to any *ordering* in the feature or category variable values. That is, as far as the *category utility* is concerned, the category set `{small,medium,large,jumbo}` is not qualitatively different from the category set `{desk,fish,tree,mop}` since the formulation of the *category utility* does not account for any ordering of the class variable. Similarly, a feature variable adopting values `{1,2,3,4,5}` is not qualitatively different from a feature variable adopting values `{fred,joe,bob,sue,elaine}`. As far as the *category utility* or *mutual information* are concerned, *all* category and feature variables are *nominal variables*. For this reason, *category utility* does not reflect any *gestalt* aspects of "category goodness" that might be based on such ordering effects. One possible adjustment for this insensitivity to ordinality is given by the weighting scheme described in the article for mutual information.

TOC Previous Next

Category "goodness": Models and Philosophy

This section provides some background on the origins of, and need for, formal measures of "category goodness" such as the *category utility*, and some of the history that lead to the development of this particular metric.

TOC Previous Next

What makes a good category?

At least since the time of Aristotle there has been a tremendous fascination in philosophy with the nature of concepts and universals. What kind of *entity* is a concept such as "horse"? Such abstractions do not designate any particular individual in the world, and yet we can scarcely imagine being able to comprehend the world without their use. Does the concept "horse" therefore have an independent existence outside of the mind? If it does, then what is the locus of this independent existence? The question of locus was an important issue on which the classical schools of Plato and Aristotle famously differed. However, they remained in agreement that universals *did* indeed have a mind-independent existence. There was, therefore, always a *fact to the matter* about which concepts and universals exist in the world.

In the late Middle Ages (perhaps beginning with Occam, although Porphyry also makes a much earlier remark indicating a certain discomfort with the status quo), however, the certainty that existed on this issue began to erode, and it became acceptable among the so-called nominalists and empiricists to consider concepts and universals as strictly mental entities or conventions of language. On this view of concepts—that they are purely representational constructs—a new question then comes to the fore: *Why do we possess one set of concepts rather than another?* What makes one set of concepts "good" and another set of concepts "bad"? This is a question that modern philosophers, and subsequently machine learning theorists and cognitive scientists, have struggled with for many decades.

What purpose do concepts serve?

One approach to answering such questions is to investigate the "role" or "purpose" of concepts in cognition. Thus, we ask: *What are concepts good for in the first place?* The answer provided by Mill & 1843/1936, p. 425) and many others is that classification (conception) is a precursor to *induction*: By imposing a particular categorization on the universe, an organism gains the ability to deal with physically non-identical objects or situations in an identical fashion, thereby gaining substantial predictive leverage (Smith & Medin 1981;Harnad 2005). As J.S. Mill puts it (Mill & 1843/1936, pp. 466–468),

From this base, Mill reaches the following conclusion, which foreshadows much subsequent thinking about category goodness, including the notion of *category utility*:

One may compare this to the "category utility hypothesis" proposed by Corter & Gluck (1992): "A category is useful to the extent that it can be expected to improve the ability of a person to accurately predict the features of instances of that category." Mill here seems to be suggesting that the best category structure is one in which object features (properties) are maximally informative about the object's class, and, simultaneously, the object class is maximally informative about the object's features. In other words, a useful classification scheme is one in which we can use category knowledge to accurately infer object properties, and we can use property knowledge to accurately infer object classes. One may also compare this idea to Aristotle's criterion of *counter-predication* for definitional predicates, as well as to the notion of concepts described in formal concept analysis.

Attempts at formalization

A variety of different measures have been suggested with an aim of formally capturing this notion of "category goodness," the best known of

which is probably the "cue validity". Cue validity of a feature with respect to category is defined as the conditional probability of the category given the feature (Reed 1972;Rosch & Mervis 1975;Rosch 1978), , or as the deviation of the conditional probability from the category base rate (Edgell 1993;Kruschke & Johansen 1999), . Clearly, these measures quantify only inference from feature to category (i.e., *cue validity*), but not from category to feature, i.e., the *category validity* . Also, while the cue validity was originally intended to account for the demonstrable appearance of *basic categories* in human cognition—categories of a particular level of generality that are evidently preferred by human learners—a number of major flaws in the cue validity quickly emerged in this regard (Jones 1983;Murphy 1982;Corter & Gluck 1992, and others).

One attempt to address both problems by simultaneously maximizing both feature validity and category validity was made by Jones (1983) in defining the "collocation index" as the product , but this construction was fairly *ad hoc* (see Corter & Gluck 1992). The *category utility* was introduced as a more sophisticated refinement of the cue validity, which attempts to more rigorously quantify the full inferential power of a class structure. As shown above, on a certain view the category utility is equivalent to the mutual information between the feature variable and the category variable. It has been suggested that categories having the greatest overall *category utility* are those that are not only those "best" in a normative sense, but also those human learners prefer to use, e.g., "basic" categories (Corter & Gluck 1992). Other related measures of category goodness are "cohesion" (Hanson & Bauer 1989;Gennari, Langley & Fisher 1989) and "salience" (Gennari 1989).

Applications

- Category utilility is used as the category evaluation measure in the popular conceptual clustering algorithm called COBWEB (Fisher 1987).

TOC Previous Next

See also

- Concept, Concept learning
- Abstraction
- Universals
- Conceptual Clustering
- Unsupervised learning

TOC Previous

References

- *Corter, James E.; Gluck, Mark A. (1992), "Explaining basic categories: Feature predictability and information" (PDF), Psychological Bulletin,* ***111*** *(2): 291–303, doi: 10.1037/0033-2909.111.2.291, archived from the original (PDF) on 2011-08-10*
- *Edgell, Stephen E. (1993), "Using configural and dimensional information", in N. John Castellan, Individual and Group Decision Making: Current Issues, Hillsdale, New Jersey: Lawrence Erlbaum, pp. 43–64*
- *Fisher, Douglas H. (1987), "Knowledge acquisition via incremental conceptual clustering", Machine Learning,* ***2*** *(2): 139–172, doi: 10.1007/BF00114265*
- *Gennari, John H. (1989), "Focused concept formation", in Alberto Maria Segre, Proceedings of the Sixth International Workshop on Machine Learning, Ithaca, NY: Morgan Kaufmann, pp. 379–382*
- *Gennari, John H.; Langley, Pat; Fisher, Doug (1989), "Models of incremental concept formation", Artificial Intelligence,* ***40*** *(1-3): 11–61, doi: 10.1016/0004-3702(89)90046-5*
- *Gluck, Mark A.; Corter, James E. (1985), "Information, uncertainty, and the utility of categories", Program of the Seventh Annual Conference of the Cognitive Science Society, pp. 283–287*
- *Hanson, Stephen José; Bauer, Malcolm (1989), "Conceptual clustering, categorization, and polymorphy", Machine Learning,* ***3*** *(4): 343–372, doi: 10.1007/BF00116838*
- *Harnad, Stevan (2005), "To cognize is to categorize: Cognition is categorization", in Henri Cohen & Claire Lefebvre, Handbook of Categorization in Cognitive Science, Amsterdam: Elsevier, pp. 19–43*
- *Jones, Gregory V. (1983), "Identifying basic categories", Psychological Bulletin,* ***94*** *(3): 423–428, doi: 10.1037/0033-2909.94.3.423*
- *Kruschke, John K.; Johansen, Mark K. (1999), "A model of probabilistic category learning", Journal of Experimental*

Psychology: Learning, Memory, and Cognition, **25** (5): 1083–1119, doi: 10.1037/0278-7393.25.5.1083
- Mill, John Stuart (1843/1936), *A System of Logic, Ratiocinative and Inductive: Being a Connected View of the Principles of Evidence and the Methods of Scientific Investigation*, London: Longmans, Green and Co. .
- Murphy, Gregory L. (1982), "Cue validity and levels of categorization", *Psychological Bulletin*, **91** (1): 174–177, doi: 10.1037/0033-2909.91.1.174
- Reed, Stephen K. (1972), "Pattern recognition and categorization", *Cognitive Psychology*, **3** (3): 382–407, doi: 10.1016/0010-0285(72)90014-x
- Rosch, Eleanor (1978), "Principles of categorization", in Eleanor Rosch & Barbara B. Lloyd, *Cognition and Categorization*, Hillsdale, New Jersey: Lawrence Erlbaum, pp. 27–48
- Rosch, Eleanor; Mervis, Carolyn B. (1975), "Family Resemblances: Studies in the Internal Structure of Categories", *Cognitive Psychology*, **7** (4): 573–605, doi: 10.1016/0010-0285(75)90024-9
- Smith, Edward E.; Medin, Douglas L. (1981), *Categories and Concepts*, Cambridge, MA: Harvard University Press
- Witten, Ian H.; Frank, Eibe (2005), *Data Mining: Practical Machine Learning Tools and Techniques*, Amsterdam: Morgan Kaufmann

Categories:

- Machine learning
- Cognitive science

This page was last edited on 23 March 2018, at 15:22.

Back to main TOC

Contents

Epidemiology of Representations

Epidemiology of representations, or cultural epidemiology, provides a conceptual framework for explaining cultural phenomena by how mental representations get distributed within a population. The theory appeals to an analogy with medical epidemiology; because “...macro-phenomena such as endemic and epidemic diseases are unpacked in terms of patterns of micro-phenomena of individual pathology and inter-individual transmission”.[1] Representations get transferred via so called cognitive causal chains (cf. Table 1). The stability of public productions and mental representations (constituting a cultural phenomenon) is explained via ecological and psychological factors. The latter include properties of the human mind and cultural epidemiologists have emphasized the significance of evolved properties: the existence of naïve theories, domain-specific abilities, principles of relevance.[2]

The theory has been formulated mainly by the French social and cognitive scientist Dan Sperber for the study of society and culture, by taking into account evidence from anthropology and cognitive science.[1]

Theory of cognitive causal chains

TOC Next

Cognitive causal chains

A cognitive causal chain (CCC) links a mental representation (e.g. satisfaction, justification, truth-value or similarity of content) with individual behaviors and mental processes (e.g. perception, inference, remembering, and the carrying out of an intention). More generally, it links something that can be perceived with the evolved and domain-specific process that makes it perceivable; for example, a visual perception of a stimulus that leads to a mental representation of the stimulus that triggered it.

Here is an example of a CCC:

> On October 31, at 7:30 p.m., Mrs. Jones's doorbell rings. Mrs. Jones hears the doorbell, and assumes that there is somebody at the door. She remembers it is Halloween: she enjoyed receiving treats as a child, and now, as an adult, she enjoys giving them. She guesses that there must be children at the door ready to trick-or-treat, and that, if she opens, she will be able to give them the candies she has bought for the occasion. Mrs. Jones decides to open the door, and does so.[1]

TOC Previous Next

Social cognitive causal chains (SCCCs)

Social cognitive causal chains (SCCCs) are inter-individual CCCs. A SCCC always implies individual CCCs but a CCC just leads to a SCCC if it involves an inter-individual act of communication or other effective forms of non-communicative interaction.

Here is an example of a SCCC involving an act of communication (ringing a doorbell):

> Billy and Julia are following the Halloween practice of going from door to door in the street, hoping to be given candies. When they reach Mrs. Jones's door, Billy rings the bell with the intention of letting the house owner know that someone is at the door, and of making her open the door ... [plug in Mrs. Jones's story as told above] ... Mrs. Jones opens the door. Billy and Julia shout 'trick or treats!' Mrs. Jones gives them candies.[1]

TOC Previous Next

Cultural cognitive causal chains

Human interaction involves many cases of ad-hoc cultural cognitive causal chains (SCCCs) that do not follow a significant long-term pattern over many people. Yet, other SCCCs can be long-lasting, systematical, and across a large population; for example, the Halloween custom mentioned above. The latter kinds of SCCCs arguably stabilize mental representations intra- and inter-individually to an extent that they can be considered as cultural if their behavior (practices and resulting artifacts) significantly represent their population. A CCCC therefore always implies SCCCs but a SCCC just leads to a CCCC if it involves one or more SCCCs that significantly indicate mental representations or public productions.

Table 1: Overview of cognitive causal chains constituting the epidemiology of representations (from [1]).

TOC Previous Next

Cultural stability, diversity, and massive modularity

Epidemiology of representations suggests that both cultural diversity and stability (macro-level) together can be explained by the massive modularity of the human brain and mind (micro-level) and SCCCs. This means that the manifold of human cultural behavior is ultimately explained by the manifold of domain-specific human cognitive abilities (mental representations) and respective SCCC. This claim would have broad impact, when applicable. It is discussed in further detail by Sperber and Hirschfeld for the cases of folkbiology, folksociology, and supernaturalism.[2] Here is an example: Think about a human cognitive sub-system that must have been very important for human cognitive evolution (i.e. a module with an innate basis); like the ability that allows humans to recognize and interpret visual patterns as faces.[3][4] One can call this cognitive sub-system the human "face recognition module". It was most likely built by evolution to recognize and interpret animal faces via decoding facial expressions produced by a complex system of facial muscles. Humans with certain types of brain damage lose this ability (c.f. prosopagnosia, Social-Emotional Agnosia). Yet, the module also processes visual input that is relatively similar to patterns of natural faces. Such can be cultural artifacts like portraits, caricatures, masks, and made-up faces.

According to the epidemiology of representation the effectiveness (defined by its relevance) of a public production depends on the extent to which it exploits a human cognitive module. Cultural artifacts "...rely on and exploit a natural disposition. Often, they exaggerate crucial features, as in caricature or in make up, and constitute what ethologists call ' superstimuli.'"[2] Two domains of cognitive modules can therefore be distinguished: the proper, natural domain and the actual, cultural domain. In the above example, the first relates to natural faces, the second to portraits, caricatures, masks, and made-up faces. Those categories can intersect, like shown in Figure 2. Since made-up faces literally overlap the

proper with the actual domain, they are the most effective and relevant public product in the example. Therefore, they lead to the most stable CCCC, if they significantly reflect the population's behavior. The other stimuli in the cultural domain will theoretically be as efficient and stable depending on the extent that they exploit the “face perception module”.[2]

Inter-individual stability of mental representations

Epidemiology of representations states that there must be a SCCC, the mechanism inter-linking a mental representation with an individual behavior, for the latter and explains its stability over time and space by the relevance theoretical status of the underlying behavior. There are three minimal conditions for an inter-individual replication that ensures transfer stability.

For *b* to be an actual replication of *a*,

1. *b* must be caused by *a* (together with situational and background conditions)
2. *b* must be similar in relevant respects to *a*
3. *b* must inherit from *a* the properties that make it relevantly similar to *a*.[1]

Here is an example:

Imagine one (A) produces a line-drawing (a), see Figure 3, and then shows it to a friend (B) for ten seconds. An asks the friend ten minutes later to reproduce it as exactly as possible with another line-drawing (b). After that, a second person is shown for ten seconds the figure drawn by your friend and presented with the same task. This is iterated with nine further participants. Now, theoretically, it is most likely that each drawing will differ from its model (a) and that the more distant two drawings are in the chain, the more they are likely to differ. Imagine further, you conduct exactly the same little experiment, but with the line-drawing in Figure 4. The result, you theoretically get this time, may be such that “...the distance in the chain of two drawings on the one hand, and their degree of difference on the other hand should be two variables independent of one another.”;[1] meaning that it was a chain of stable replications.

Theoretically, this is because Figure 4 looks like a five-branched star, drawn without lifting the pencil, whereas Figure 3 has no perceivable

meaning (at least in our western culture), the second chain is a SCCC but not so the first. Arguably and on the one hand, the second causal chain was driven by perceiving the shared meaning of the stimulus by inferring the underlying mental representation and a sequential reproduction of by new behavior. On the other hand, the first causal chain was driven by mere imitation that does not crucially depends on recognition of the underlying meaning. There are forms of inter-individual transfer of behavior that blend reproduction and imitation to different extends. However, the more the meaning of a stimulus is actually reproduced rather than imitated by a subject, the more stable the transfer of the underlying mental representation is supposed to be over time.[5]

Epidemiology of representations, cognitive science and domain specificity

Like cognitive science, the epidemiology of representations is also based on the assumption that domain specificity characterizes cognitive abilities or mechanisms.[6] Epidemiology of representations assumes that human animals are cognitively predefined by their evolved neurophysiology (i.e. their cognition is massively modular). However, it also acknowledges that cognitive development plays a functional role for the formation of mental representations, concepts, intuitive theories, and the like.[1][2] Accordingly, theories in cognitive science argue that humans are evolutionarily equipped with a certain brain-body setup (c.f. common coding theory) that allows them to encode and decode specific kinds of information to their memory via interacting with their environment. This is sensory-specific (i.e. visual-, acoustic-, tactile-, and olfactory perception etc.) and task or reasoning specific (i.e. formulation of intuitive theories). Hence, by these theories, humans are assumed to have (1) an innate cognitive potential that (2) is realized during a natural cognitive development.[6][7] The reason for the first argument comes from fields like evolutionary anthropology and evolutionary psychology, stating that evolution has been selecting merely those animals that have evolved adaptive mental and neural mechanisms to efficiently cope with specific challenges regarding their environment (e.g. getting food, shelter, mates, etc.).[8] The reason for the second argument comes from cognitive development, stating that animals (especially humans) in their infancy are highly sensitive to input patterns, since their cognitive system automatically and rapidly adapts their environment.[7]

Since the human brain is organized into areas that focus on the processing of distinct sensory input and output and also interact with one another, humans are assumed to learn and perform best in processing those patterns of information for which their neurophysiological system has been evolved.[6] Mental representations manifest, for example, in human long-

term memory (Figure 1). Other evidence for massive modularity is that human cognitive performance for respective domains correlates with the degree of damage to the corresponding cortical areas.[9]

TOC Previous Next

Epidemiology of representations versus memetics

See also: Evolutionary psychology and culture

The cognitive approach in the epidemiology of representations differs from other philosophical theories with evolutionary orientation, such as memetics, formulated by the British ethologist and evolutionary biologist Richard Dawkins (cf.[10][11]). Roughly speaking, the three crucial differences between the two approaches are the following:

1. epidemiology of representations atomizes culture to mental representations and individual behavior, whereas memetics atomizes culture to memes
2. individual behavior in SCCC is replicated, whereas memes are imitated (cf. Inter-Individual Stability of Mental Representations)
3. stability of mental representation over time is explained by relevance and domain specificity of individual behavior, whereas stability of memes depends on the benefit of their own transmission. [5]

With the epidemiology of representations, Sperber has argued that the notion of meaning is disregarded in memetics and that this is questionable since the study of society and culture without an explanation of how meaning is perceived and reproduced is contradictory.[5] If memetics, nevertheless, attempts to explain culture based on evolutionary biology, it will need to present empirical evidence for the transfer of memes, that is "...showing that elements of culture inherit all or nearly all their relevant properties from other elements of culture that they replicate ".[5]

TOC Previous

References

1. ^ a b c d e f g h *Sperber, D. (2001). "Conceptual tools for a natural science of society and culture (Radcliffe-Brown Lecture in Social Anthropology 1999)". Proceedings of the British Academy. **111**: 297–317.*
2. ^ a b c d e *Sperber, D.; Hirschfeld, L. (1999). Culture, Cognition, and Evolution. Cambridge, Mass.: In Robert Wilson & Frank Keil (eds) MIT Encyclopedia of the Cognitive Sciences. pp. cxi–cxxxii.*
3. ^ *Meltzoff, A.; Keith Moore, M. (1994). "Imitation,Memory, and the Representation of Person". Infant Behavior and Development. **17**: 83–99. doi:10.1016/0163-6383(94)90024-8. PMC 4137868 .*
4. ^ *Morton, J.; Johnson, M.H. (1991). "CONSPEC and CONLERN: a two-process theory of infant face recognition". Psychological Review. 2. **98** (2): 164–81. doi:10.1037/0033-295X.98.2.164. PMID 2047512.*
5. ^ a b c d *Sperber, D. (2000). An Objection to the Memetic Approach to Culture. Oxford: in Robert Aunger ed. Darwinizing Culture: The Status of Memetics as a Science.*
6. ^ a b c *Bermúdez, José Luis (2010). Cognitive science: An introduction to the science of the mind. Cambridge Univ Press.*
7. ^ a b *Carey, S. (2009). The Origin of Concepts. USA: Oxford University Press.*
8. ^ *Cosmides, L.; Tooby, J. (1992). In J. Barkow, L. Cosmides, and J. Tooby, eds., The Adapted Mind. Oxford: Oxford University Press. pp. 163–228.*
9. ^ *Kandel, E.R.; Schwartz, J.H.; Jessell, T.M. (2000). Principles of Neural Science. New York: McGraw-Hill.*
10. ^ *Dawkins, R. (1976). The Selfish Gene. Oxford: Oxford University Press.*
11. ^ *Dawkins, R. (1982). The Extended Phenotype. Oxford: Oxford University Press.*

Categories:

- Cognitive science

- Epidemiology

This page was last edited on 15 May 2018, at 18:33.

Back to main TOC

Cognitive Philology

Jump to navigation Jump to search

Cognitive philology is the science that studies written and oral texts as the product of human mental processes. Studies in cognitive philology compare documentary evidence emerging from textual investigations with results of experimental research, especially in the fields of cognitive and ecological psychology, neurosciences and artificial intelligence. "The point is not the text, but the mind that made it". Cognitive Philology aims to foster communication between literary, textual, philological disciplines on the one hand and researches across the whole range of the cognitive, evolutionary, ecological and human sciences on the other.[1]

Cognitive philology:

- investigates transmission of oral and written text, and categorization processes which lead to classification of knowledge, mostly relying on the information theory;
- studies how narratives emerge in so called natural conversation and selective process which lead to the rise of literary standards for storytelling, mostly relying on embodied semantics;
- explores the evolutive and evolutionary role played by rhythm and metre in human ontogenetic and phylogenetic development and the pertinence of the semantic association during processing of cognitive maps;
- Provides the scientific ground for multimedia critical editions of literary texts.

Among the founding thinkers and noteworthy scholars devoted to such investigations are:

- Gilles Fauconnier,[2] A professor in Cognitive science at the University of California, San Diego. He was one of the founders of

cognitive linguistics in the 1970s through his work on pragmatic scales and mental spaces. His research explores the areas of conceptual integration and compressions of conceptual mappings in terms of the emergent structure in language.[3]

- Alan Richardson: Studies Theory of Mind in early-modern and contemporary literature. [2]
- David Herman: Professor of English at North Carolina State University and an adjunct professor of linguistics at Duke University. He is the author of "Universal Grammar and Narrative Form" and the editor of "Narratologies: New Perspectives on Narrative Analysis[4]
- Mark Turner
- Benoît de Cornulier
- François Recanati
- Manfred Jahn in Germany
- Paolo Canettieri
- Domenico Fiormonte
- Anatole Pierre Fuksas
- Luca Nobile
- Julián Santano Moreno

References

1. ^ "Cognitive Philology". DigiLab, Servizi di publishing digitale. Retrieved 21 June 2016.
2. ^ a b Harbus, Antonina (2012). Cognitive approaches to Old English poetry (1. publ. ed.). Cambridge [England]: D.S. Brewer. ISBN 978-1843843252.
3. ^ Geeraerts, Dirk; Cuyckens, Hubert (2010). The Oxford handbook of cognitive linguistics (1. issued as an Oxford Univ. Press pbk. ed.). Oxford: Oxford University Press. ISBN 978-0199738632.
4. ^ Herman, David (2003). Narrative theory and the cognitive sciences ([Nachdr.]. ed.). Stanford, Calif.: Center for the Study of Language and Information. ISBN 978-1575864679.

See also

- Cognitive linguistics
- Philology
- Information Theory
- Cognitive Psychology
- Cognitive Poetics
- Cognitive rhetoric
- Artificial Intelligence
- Cognitive archaeology

External links

- (in Italian) Rivista di Filologia Cognitiva
- Cognitive Philology
- CogLit: Literature and Cognitive Linguistics
- Institute for Psychological Study of the Arts

TOP

Categories:

- Historical linguistics
- Philology
- Writing
- Cognitive psychology
- Artificial intelligence
- Cognitive science

This page was last edited on 30 September 2016, at 12:49.

Back to main TOC

Contents

Subgoal Labeling

Subgoal labeling is giving a name to a group of steps, in a step-by-step description of a process, to explain how the group of steps achieve a related subgoal. This concept is used in the fields of cognitive science and educational psychology.

Lower-level steps of a worked example are grouped into a meaningful unit and labeled. This labeling helps learners identify the structural information from incidental information.[1] Learning subgoals can reduce cognitive load when problem solving because the learner has fewer possible problem-solving steps to focus.[1] Subgoal-labeled worked examples might provide learners with mental model frameworks. In a recent study, Learners who were given labels for subgoals used those labels when explaining how they solved a problem, suggesting that's how they mentally organized the information.[1]

Introduction

Generally problem solving adopts a very procedural approach. Problem solving in the areas of science, technology, engineering and mathematics (STEM) has been highly procedural. The best approach so far is to teach these procedures through instructional text accompanied by specific worked examples. The role of instructional text is to define and describe the problem solving procedures whereas how to apply these procedures is shown through worked examples.[2] Students can learn from step-by-step approach of worked examples which later can be helpful to them in solving similar problems on their own.[3] Novices, however, often find it difficult to distinguish domain specific information and the information specific to solving that problem, which increases their cognitive load.[4] This cognitive load can be reduced by use of subgoal labeling which is achieved by grouping functionally-similar steps under a label that describes that function. This approach can be helpful to students to form a mental model of the domain related problem which later can guide them to solve different problems in that domain.[4] Understanding the structure of worked example can help students identify the similarities between different problems thus encouraging self-explanation and learning.[5]

Application

Subgoal labels have been used in worked examples to teach learners to solve problems in STEM domains [2] Pairing subgoal labeled instructional text with subgoal labeled worked examples can further improve learners performance in problem solving in a computer-based learning environment (e.g. online learning) without personal interaction with an instructor.[3][4] Subgoal labels can be used in different important areas such as teaching and learning novel problem solving, in training teachers to teach technical subjects (e.g. teaching computer programming), multi agent programming, professional development, online learning and other types of lifelong learning (e.g. Subgoal labeled instruction material helped novices to program in App Inventor for Android).[1][3][4][5][6]

TOC Previous Next

See also

- Educational psychology
- Education technology
- E-learning
- Human-computer interaction
- Agent-based model

TOC Previous

References

1. ^ a b c d *Margulieux, L. E., Guzdial, M., & Catrambone, R. (September 2012). "Subgoal-labeled instructional material improves performance and transfer in learning to develop mobile applications". ICER '12, Proceedings of the ninth annual international conference on International computing education research: 71–78. doi:10.1145/2361276.2361291.*
2. ^ a b Margulieux, L. E. (2014). Subgoal Labeled Instructional Text and Worked Examples in STEM Education
3. ^ a b c Margulieux, L. E., Catrambone, R., & Guzdial, M. Subgoal Labeled Worked Examples Improve K-12 Teacher Performance in Computer Programming Training (2013)
4. ^ a b c d Catrambone, R. (1995). Aiding subgoal learning: Effects on transfer. *Journal of Educational Psychology*, 87(1), 5.
5. ^ a b Catrambone, R. (1998). The subgoal learning model: Creating better examples so that students can solve novel problems. *Journal of Experimental Psychology: General*, 127(4), 355.
6. ^ Chiu, C. C., & Soo, V. W. (2007). Subgoal Identification for Reinforcement Learning and Planning in Multiagent Problem Solving (pp. 37-48). Springer Berlin Heidelberg.

Categories:

- Educational research
- Human–computer interaction
- Cognitive science
- Educational psychology

This page was last edited on 25 March 2018, at 11:43.

List of authors: https://tools.wmflabs.org/xtools/wikihistory/wh.php?page_title=Subgoal_labeling

Back to main TOC

Contents

Embodied bilingual Language

Embodied bilingual language, also known as **L2 embodiment**, is the idea that people mentally simulate their actions, perceptions, and emotions when speaking and understanding a second language (L2) as with their first language (L1).[1] It is closely related to embodied cognition and embodied language processing, both of which only refer to native language thinking and speaking. An example of embodied bilingual language would be situation in which a L1 English speaker learning Spanish as a second language hears the word *rápido* ("fast") in Spanish while taking notes and then proceeds to take notes more quickly.

Overview

Embodied bilingual language refers to the role second language learning plays in embodied cognition, which proposes that the way the body interacts with its environment influences the way a person thinks or creates mental images.[2]

Embodied cognition theory assumes that embodiment occurs automatically and in a person's native tongue.[3] Embodied theories of language posit that word meaning is grounded in mental representations of action, perception, and emotion.[2] Thus, L2 embodiment presupposes that embodied cognition takes place in a language that was learned later in life, outside of a child's critical period of learning a language. In embodied bilingual language, a second language as well as the first language connects cognition with physical body movements.[1]

For example, in first language (L1) embodiment, research shows that participants are quicker to comprehend sentences if they are simultaneously presented with pictures describing the actions in the sentence.[4] Embodied language assumes that comprehension of language requires mental simulation, or imagination, of the subject and action of a sentence that is being processed and understood. Following L1 embodiment, L2 embodiment supposes that the understanding of sentences in L2 also require the same mental processes that underlie first language comprehension.[1]

TOC Previous Next

Theory

Research shows that embodiment is present in native language processing,[3] and if embodiment occurs in first language processing, then embodiment might also occur in second language processing.[5] How second language is embodied compared to first language is still a topic of debate. Currently, there are no known theories or models that address the presence or absence of embodiment in second language processing, but there are bilingual processing models that can lead to multiple hypotheses of embodiment effects in second language learning.[6]

TOC Previous Next

Revised hierarchical model (RHM)

The revised hierarchical model (RHM) hypothesizes that lexical connections are stronger from L2 to L1 than from L1 to L2. In other words, translating a word from second language to first language occurs faster than vice versa.[7] However, while translating from native language to second language might be delayed, the semantics, or word meanings of the information being conveyed, are maintained and understood by the translator.

What this means in terms of embodied bilingual language is that there should be no difference in embodiment effects between first language processing and second language processing. Because the RHM model posits that semantic representations are shared across languages, meanings found in first language action, perception, and emotion will transfer equally into second language processing[6]

TOC Previous Next

Extended bilingual interactive activation (BIA+) model

According to the BIA+ model of bilingual lexical processing, the brain activates both languages when recognizing a word in either language. Rather than selecting a single language, lexical access, or the sound-

meaning connections of a language, is non-selective across languages. The BIA+ model suggests that orthographic representations activate first, followed by their associated phonological and semantic representations. The speeds of these activations depend on frequency of use of the language. Given this proposition, if second language is used less often than first language, second language activation occurs more slowly than first language activation. However, the BIA+ model argues that these differences in activation time are minuscule.[8]

Similar to the RHM, the BIA+ model says that while there are slight differences in time when accessing word meanings in both first and second languages, the semantic representations are maintained. Thus, in terms of embodiment, the BIA+ model would suggest that embodiment effects, too, are maintained across native and second language processing.[6]

TOC Previous Next

Sense model

The sense model takes a different position from the previously stated models. The sense model supposes that native language words are associated with a greater number of semantic senses than second language words and argues for partially overlapping distributed semantic representations for L1 and L2 words. As a result, the sense model argues that semantic representations in second language are "less rich" than in those in the native language.[9] If this is the case in embodied bilingual language, then embodiment in second language processing may be minimal or even completely lacking.[6]

TOC Previous Next

Action

Non-selective motor systems

Embodied bilingual processing is rooted in motor processing because research shows that the motor cortex activates during language processing. In first language processing, for example, leg-related words like "kick" and "run" stimulate the part of the motor cortex that controls leg motions.[10] This illustrates that language describing motor actions activates motor systems in the brain, but only when the words provide literal meaning as opposed to figurative meaning.[11] Following L1 embodiment, L2 embodiment assumes that the words "punch" and "throw" in a second language will also stimulate the same parts of the motor cortex as does first language words.[1] In essence, language that describes motor actions activates motor systems in the brain.[1] If this holds true for all languages, then the processing that occurs when understanding and using a second language must also activate motor regions of the brain, just as native language processing does.

Research shows that both first and second language action words rely on the motor cortex for language processing, strengthening the claim that the motor cortex is necessary for action language processing.[5] This research suggests that action language processing has direct access to semantic motor representations in both languages.[6] This results from second language motor systems calling on and activating information from first language motor systems. Initially, the semantic representations stimulated by the first language are stronger than that of the second language. But with more experience and exposure to the second language, sensorimotor involvement and second language comprehension becomes stronger.[10] The more often a second language is used, the stronger the neural networks and associations become, and thus some researchers argue that semantic representations in second language become just as prominent as for first language.[12]

Perception

Grounded or embodied cognition is a theoretical view that assumes knowledge is represented in the mind as modal representations, which are memories of perceptual, motor, and affective experiences.[2] Perceptual features include orientation, location, visibility conditions, motion, movement direction, and action direction. All of these perceptual features are necessary for comprehending language. If this is true for first language processing, then this must also be true for second language processing.[11]

These perceptual features occur when imagining an action, recalling an action, and observing various sensory information.[6] In addition to motor brain areas, somatosensory areas, which deal with touch and physical awareness, are also activated. This sensory information contributes to formulating the mental simulation, or imagination of the action being described, that necessitates language comprehension[11]

Finally, research shows that embodied bilingual language processing not only activates the perceptual simulation of first and second language meanings, but this activation is automatic.[5] Second language users automatically stimulate word meanings in a detailed perceptual fashion. Rather than consciously using strategies for language comprehension, bilinguals automatically perceive and construct meaning.

TOC | Previous | Next

Emotion

Embodied bilingual language also assumes that comprehension of language activates parts of the brain that correspond with emotion. Research provides evidence that emotion words are embedded in a rich semantic network.[13] Given this information, emotion is better perceived in a first language because linguistic development coincides with conceptual development and development of emotional regulation systems. Linguistic conditioning spreads to phonologically and semantically related words of the same language, but not to translation equivalents of another language.

TOC Previous Next

Disembodied bilingual language and emotion

Some researchers have argued for disembodied cognition when it comes to processing emotion. The idea of disembodied cognition comes from research, which shows that less emotion is shown by a bilingual person when using a second language. This may illustrate that less emotionality is attached to second language, which then leads to the reduction of biases such as decision bias or framing bias.[14] One study examining the anxiety effects of L2 words such as "death" found that those with lower levels of proficiency in L2 were more likely than L1 speakers to experience feelings of anxiety.[15][*clarification needed*] Because the emotion is less interpreted during second language processing, speakers will be more likely to ignore or fail to comprehend the emotion of a situation when making decisions or analyzing situations. However, others have found that such and similar results may be due not so much to an emotions-based explanation, as the fact that speaking in a second/foreign language seems to release the speaker from the social norms, limitations and political correctness imposed by their mother tongue.[16]

The theory of disembodied cognition posits that because emotions are not as clearly recognized in a second language versus a first language, emotions will not affect and bias a person who is using a second language

as much as using a first language. This lack of comprehension of emotion provides evidence for the sense model, which hypothesizes that embodied cognition fails to be present in second language processing.

TOC Previous

References

1. ^ a b c d e Vukovic, Nikola; Shtyrov, Yury (2014). "Cortical motor systems are involved in second-language comprehension: Evidence from rapid mu-rhythm desynchronisation". NeuroImage. **102**: 695–703. doi:10.1016/j.neuroimage.2014.08.039. PMID 25175538.
2. ^ a b c Barsalou, Lawrence (1999). "Perceptual symbol systems". Behavioral and Brain Sciences. **22** (44): 577–660. doi:10.1017/S0140525X99002149.
3. ^ a b Bergen, Benjamin; Lau, Ting-Ting Chan; Narayan, Schweta; Stojanovic, Diana; Wheeler, Kathryn (2010). "Body part representations in verbal semantics". Memory and Cognition. **38** (7): 969–981. doi:10.3758/MC.38.7.969.
4. ^ Glenberg, Arthur (2002). "Grounding language in action". Psychonomic Bulletin & Review. **9** (3): 558–565. doi:10.3758/BF03196313.
5. ^ a b c Vukovic, N; Williams, J (2014). "Automatic perceptual simulation of first language meanings during second language sentence processing in bilinguals". Acta Psychologica. **145**: 98–103. doi:10.1016/j.actpsy.2013.11.002.
6. ^ a b c d e f De Grawe, S; Willems, R.M.; Rueschemeyer, S; Lemhöfer, K; Schriefers, H (2014). "Embodied language in first- and second-language speakers: Neural correlates of processing motor verbs". Neuropsychologia. **56**: 334–349. doi:10.1016/j.neuropsychologia.2014.02.003. PMID 24524912.
7. ^ Kroll, Judith; Stewart, Erika (1994). "Category interference in translation and picture naming: Evidence for asymmetric connection between bilingual memory representations". Journal of Memory and Language. **33** (2): 149–174. doi:10.1006/jmla.1994.1008.
8. ^ Dijkstra, Tom; Van Heuven, Walter (2002). "The architecture of the bilingual word recognition system: From identification to decision". Bilingualism: Language and Cognition. **5** (3): 175–197. doi:10.1017/S1366728902003012.
9. ^ Finkbeiner, Matthew; Forster, Kenneth; Nicol, Janet; Nakamura, Kumiko (2004). "The role of polysemy in masked semantic and

translation priming". Journal of Memory and Language. ***51****: 1–22. doi:10.1016/j.jml.2004.01.004.*

10. ^ [a] [b] *Pulvermüller, F; Härle, M; Hummel, F (2001). "Walking or Talking?: Behavioral and Neurophysiological Correlates of Action Verb Processing". Brain and Language.* ***78*** *(2): 143–168. doi:10.1006/brln.2000.2390.*
11. ^ [a] [b] [c] *Bergen, Benjamin; Wheeler, Kathlyn (2010). "Grammatical aspect and mental simulation". Brain and Language.* ***112****: 150–158. doi:10.1016/j.bandl.2009.07.002.*
12. ^ *Dudschig, C; Kaup, B (2013). "Embodiment and second-language: Automatic activation of motor responses during processing spatially associated L2 words and emotion L2 words in a vertical stroop paradigm". Embodiment and second-language: Automatic activation of motor responses during processing spatially associated L2 words and emotion L2 words in a vertical stroop paradigm.* ***132****: 14–21. doi:10.1016/j.bandl.2014.02.002.*
13. ^ *Pavlenko, A (2008). "Emotion and emotion-laden words in the bilingual lexicon". Bilingualism: Language and Cognition.* ***11****: 147–165. doi:10.1017/S1366728908003283.*
14. ^ *Pavlenko, A (2012). "Affective processing in bilingual speakers: Disembodied cognition?". International Journal of Psychology.* ***47*** *(6): 405–428. doi:10.1080/00207594.2012.743665.*
15. ^ *Keysar, B; Hayakawa, S; An, S (2012). "The foreignlanguage effect: Thinking in a foreign tongue reduces decision biases". Psychological Science.* ***23****: 661–668. doi:10.1177/0956797611432178. PMID 22517192.*
16. ^ *Gawinkowska M, Paradowski MB, Bilewicz M (2013). "Second language as an exemptor from sociocultural norms. Emotion-Related Language Choice revisited". PLoS ONE.* ***8*** *(12): e8122. doi:10.1371/journal.pone.0081225. PMC 3859501 . PMID 24349044.*

Categories:

- Bilingualism
- Cognitive science

This page was last edited on 8 September 2017, at 21:33.

Back to main TOC

Anthony Leiserowitz

Jump to navigation Jump to search

Anthony Leiserowitz is a human geographer at Yale University who studies public perceptions of climate change.

Leiserowitz grew up on a farm in Michigan and his parents were sculptors. He received his undergraduate degree at Michigan State University and then went on to the University of Oregon to study under Paul Slovic, an expert in risk perception, and received his PhD in human geography. He joined the faculty of Yale in 2007. He started to collaborate with Edward Maibach in 2008 to study people's perception of climate change.[1]

Leiserowitz is the Director of the Yale Project on Climate Change Communication, a principal investigator at the Center for Research on Environmental Decisions at Columbia University, and a research scientist at Decision Research.[2]

He was the recipient of the Environmental Protection Agency (EPA's) 2011 Environmental Merit Award,[3] and as of 2013 had published around 100 scientific articles and book chapters on climate change beliefs, perceptions and behaviors.[4]

Selected papers

- *Leiserowitz, A. (2005). "American Risk Perceptions: Is Climate Change Dangerous?". Risk Analysis.* ***25*** *(6): 1433–1442. doi: 10.1111/j.1540-6261.2005.00690.*
- *Leiserowitz, A. (2006). "Climate Change Risk Perception and Policy Preferences: The Role of Affect, Imagery and Values". Climatic Change.* ***77*** *(1–2): 45–72. doi: 10.1007/s10584-006-9059-9.*
- *Maibach, E.; Leiserowitz, A.; Roser-Renouf, C.; Mertz, C. (2011). "Identifying Like-Minded Audiences for Global Warming Public*

Engagement Campaigns: An Audience Segmentation Analysis and Tool Development". *PLOS ONE*. ***6*** *(3): e17571. doi: 10.1371/journal.pone.0017571. PMC 3053362. PMID 21423743.*

- *Leiserowitz, A.; Kates, R.; Parris, T. (2006). "Sustainability Values, Attitudes, and Behaviors: A Review of Multinational and Global Trends". Annual Review of Environment and Resources.* ***31****: 413–444. doi: 10.1146/annurev.energy.31.102505.133552.*
- *Leiserowitz, A.; Maibach, E.; Roser-Renouf, C.; Smith, N.; Dawson, E. (2013). "Climategate, public opinion, and the loss of trust". American Behavioral Scientist.* ***57*** *(6): 818–837. doi: 10.1177/0002764212458272.*

References

1. ^ *Banerjee, Neela (January–February 2015). "What do Americans think about global warming?". Yale Alumni Magazine.*
2. ^ *"Staff". Yale Project on Climate Change Communication. Retrieved December 4, 2013.*
3. ^ *"2012 Environmental Merit Award Recipients". EPA. Retrieved January 26, 2016.*
4. ^ *"Leiserowitz Publications". Yale. Retrieved December 4, 2013.*

Further reading

- *"Interview with Anthony Leiserowitz". Knowledge Networks. Fall–Winter 2010.* </ref>

TOP

Categories:

- American geographers
- American political scientists
- American social scientists
- Climate change
- Global warming
- Living people
- Yale University faculty
- University of Oregon alumni
- Michigan State University alumni

This page was last edited on 20 April 2018, at 10:10.

Back to main TOC

Cognitive hearing Science

Jump to navigation Jump to search

Cognitive hearing science is an interdisciplinary science field concerned with the physiological and cognitive basis of hearing and its interplay with signal processing in hearing aids. The field includes genetics, physiology, medical and technical audiology, cognitive neuroscience, cognitive psychology, linguistics and social psychology.

Theoretically the research in cognitive hearing science combines a physiological model for the information transfer from the outer auditory organ to the auditory cerebral cortex, and a cognitive model for how language comprehension is influenced by the interplay between the incoming language signal and the individual's cognitive skills, especially the long-term memory and the working memory.[1]

Researchers examine the interplay between type of hearing impairment or deafness, type of signal processing in different hearing aids, type of listening environment and the individual's cognitive skills.

Research in cognitive hearing science has importance for the knowledge about different types of hearing impairment and its effects, as for the possibilities to determine which individuals can make use of certain type of signal processing in hearing aid or cochlear implant and thereby adapt hearing aid to the individual.[2]

Cognitive hearing science has been introduced by researchers at the Linköping University research centre Linnaeus Centre HEAD (HEaring And Deafness) in Sweden, created in 2008 with a major 10-year grant from the Swedish Research Council.

References

1. ^ *"Project database"*. *Swedish Research Council. Retrieved 2010-12-06.*
2. ^ *"About Linnaeus Centre Head p. 3-4"* (PDF). *Linköping University. Retrieved 2010-12-06.*

Resources

- Linnaeus Centre HEAD
- Interview, prof. Jerker Rönnberg

TOP

Categories:

- Cognitive science
- Audiology
- Cognitive neuroscience
- Linguistics
- Animal genetics
- Physiology
- Signal processing
- Cognitive psychology
- Social psychology

This page was last edited on 10 August 2017, at 07:22.

Back to main TOC

Fictive Motion

Jump to navigation Jump to search

Fictive motion is the metaphorical motion of an object or abstraction through space.[1][2][3] Fictive motion has become a subject of study in psycholinguistics and cognitive linguistics. In fictive motion sentences, a motion verb applies to a subject that is not literally capable of movement in the physical world, as in the sentence, "The fence runs along the perimeter of the house." Fictive motion is so called because it is attributed to material states, objects, or abstract concepts, that cannot (sensibly) be said to move themselves through physical space. Fictive motion sentences are pervasive in English and other languages.

History

Cognitive linguist Leonard Talmy discussed many of the spatial and linguistic properties of fictive motion in a book chapter called "Fictive motion in language and 'ception' " (Talmy 1996). He provided further insights in his seminal book, *Toward a Cognitive Semantics Vol. 1*, in 2000. Talmy began analyzing the semantics of fictive motion in the late 1970s and early 1980s but used the term "virtual motion" at that time (e.g. Talmy 1983).

Fictive motion has since been investigated by cognitive scientists interested in whether and how it evokes dynamic imagery. Methods of investigation have included reading tasks,[4] eye-tracking tasks[4][5] and drawing tasks.[6]

Influence on perception of time

A recent avenue of research has focused on fictive motion's influence on perceptions of time. People often speak about time in terms of motion. English speakers may describe themselves as moving through time toward or past events with statements such as "we're entering the holidays" or "we slipped past the due date." They may also talk about events as moving toward or past themselves with statements such as "tough times are approaching us" or "summer vacation has passed".[7][8] Broadly speaking, metaphorical talk about time borrows from two different perspectives for conceptualizing motion. In the ego-moving metaphor, one progresses along a timeline toward the future, while in the time-moving metaphor, a timeline is conceived as a conveyor belt upon which events move from the future to the past like packages.[9][10] (e.g. Lakoff 1987).

Interestingly, it appears that not only does thinking about actual motion influence people's judgments about time, but thinking about fictive motion has the same effect,[11][12] suggesting that thinking about one abstract domain may influence people's understanding of another. This raises the question of whether the influence of fictive motion on people's understanding of time is rooted in a concrete, embodied conception of motion, such that both time and fictive motion are ultimately understood in terms of simulations of concrete experience,[13] or whether the effects of fictive motion are a product of the way that language influences thought.[14]

References

1. ^ Ramscar, M., Matlock, T., & Dye, M. (2009) Running down the clock: the role of expectation in our understanding of time and motion. Language and Cognitive Processes.
2. ^ *Matlock, T. (2004). Fictive motion as cognitive simulation. Memory & Cognition, 32, 1389-1400.
3. ^ Talmy, Leonard (2000). Toward a Cognitive Semantics Vol. 1. MA: MIT Press.
4. ^ *a* *b* Matlock, T., & Richardson, D. C. (2004). Do eye movements go with fictive motion? Proceedings of the 26th Annual Conference of the Cognitive Science Society.
5. ^ Richardson, D.C & Matlock, T. (2007). The integration of figurative language and static depictions: An eye movement study of fictive motion. Cognition, 102, 129-138
6. ^ Matlock, T. (2006). Depicting fictive motion in drawings. In J. Luchenbroers, (Ed.), Cognitive Linguistics: Investigations across languages, fields, and philosophical boundaries. Amsterdam: John H. Benjamins.
7. ^ Boroditsky, L. (2000). Metaphoric structuring: Understanding time through spatial metaphors. Cognition, 75, 1-28.
8. ^ Boroditsky, L., & Ramscar, M. (2002). The roles of body and mind in abstract thought. Psychological Science, 13, 185-188.
9. ^ Gentner, D. (2001). Spatial metaphors in temporal reasoning. In M.Gattis (Ed.) Spatial schemas and abstract thought (pp. 203-222). Cambridge: MIT Press.
10. ^ Lakoff, G. (1987). Women, fire, and dangerous things: What categories reveal about the mind. Chicago, IL: University of Chicago Press.
11. ^ Ramscar, M., Boroditsky, L., & Matlock, T. (2009) Time, motion, and meaning: The experiential basis of abstract thought. In Kelly S. Mix, Linda B. Smith, and Michael Gasser (eds.), The Spatial Foundations of Language and Cognition. Oxford: Oxford University Press.
12. ^ Matlock, T, Ramscar, M., & Boroditsky, L. (2005). The experiential

link between spatial and temporal language. Cognitive Science, 29, 655-664.
13. ^ Langacker, R. W. (1999). Grammar and Conceptualization. Berlin & New York: Mouton de Gruyter
14. ^ Slobin, D. I. (1996). "From 'thought and language' to 'thinking for speaking' ". In Rethinking Linguistic Relativity, J. J. Gumperz and S. C. Levinson (eds), 70-96. Cambridge: Cambridge University Press

- Fauconnier, G & Turner, M. (2002). The Way We Think: Conceptual Blending and the Mind's Hidden Complexities. New York: Oxford University Press. Pages 376-380.
- Lakoff, G., & Johnson, M. (1999) Philosophy In The Flesh: the Embodied Mind and its Challenge to Western Thought. New York: Basic Books.

TOP

Categories:

- Cognitive science
- Psycholinguistics
- Motor control

This page was last edited on 31 October 2012, at 08:22.

Back to main TOC

Contents

Neuroscience

Jump to navigation Jump to search
For the journal, see Neuroscience (journal).
"Brain science" redirects here. For other aspects of brain science, see cognitive science, cognitive psychology, neurology, and neuropsychology.

Neuroscience (or **neurobiology**) is the scientific study of the nervous system.[1] It is a multidisciplinary branch of biology,[2] that combines physiology, anatomy, molecular biology, developmental biology, cytology, mathematical modeling and psychology to understand the fundamental and emergent properties of neurons and neural circuits.[3][4][5][6][7] The understanding of the biological basis of learning, memory, behavior, perception and consciousness has been described by Eric Kandel as the "ultimate challenge" of the biological sciences.[8]

The scope of neuroscience has broadened over time to include different approaches used to study the nervous system at the different scales and the techniques used by neuroscientists have expanded enormously, from molecular and cellular studies of individual neurons to imaging of sensory and motor tasks in the brain. Neuroscience has also given rise to such other disciplines as neuroeducation,[9] neuroethics, and neurolaw.

As a result of the increasing number of scientists who study the nervous system, several prominent neuroscience organizations have been formed to provide a forum to all neuroscientists and educators. For example, the International Brain Research Organization was founded in 1960,[10] the International Society for Neurochemistry in 1963,[11] the European Brain and Behaviour Society in 1968,[12] and the Society for Neuroscience in 1969.[13]

History

Main article: History of neuroscience

The earliest study of the nervous system dates to ancient Egypt. Trepanation, the surgical practice of either drilling or scraping a hole into the skull for the purpose of curing headaches or mental disorders, or relieving cranial pressure, was first recorded during the Neolithic period. Manuscripts dating to 1700 BC indicate that the Egyptians had some knowledge about symptoms of brain damage.[14]

Early views on the function of the brain regarded it to be a "cranial stuffing" of sorts. In Egypt, from the late Middle Kingdom onwards, the brain was regularly removed in preparation for mummification. It was believed at the time that the heart was the seat of intelligence. According to Herodotus, the first step of mummification was to "take a crooked piece of iron, and with it draw out the brain through the nostrils, thus getting rid of a portion, while the skull is cleared of the rest by rinsing with drugs."[15]

The view that the heart was the source of consciousness was not challenged until the time of the Greek physician Hippocrates. He believed that the brain was not only involved with sensation—since most specialized organs (e.g., eyes, ears, tongue) are located in the head near the brain—but was also the seat of intelligence. Plato also speculated that the brain was the seat of the rational part of the soul.[16] Aristotle, however, believed the heart was the center of intelligence and that the brain regulated the amount of heat from the heart.[17] This view was generally accepted until the Roman physician Galen, a follower of Hippocrates and physician to Roman gladiators, observed that his patients lost their mental faculties when they had sustained damage to their brains.

Abulcasis, Averroes, Avicenna, Avenzoar, and Maimonides, active in the Medieval Muslim world, described a number of medical

problems related to the brain. In Renaissance Europe, Vesalius (1514–1564), René Descartes (1596–1650), and Thomas Willis (1621–1675) also made several contributions to neuroscience.

In the first half of the 19th century, Jean Pierre Flourens pioneered the experimental method of carrying out localized lesions of the brain in living animals describing their effects on motricity, sensibility and behavior. Studies of the brain became more sophisticated after the invention of the microscope and the development of a staining procedure by Camillo Golgi during the late 1890s. The procedure used a silver chromate salt to reveal the intricate structures of individual neurons. His technique was used by Santiago Ramón y Cajal and led to the formation of the neuron doctrine, the hypothesis that the functional unit of the brain is the neuron.[18] Golgi and Ramón y Cajal shared the Nobel Prize in Physiology or Medicine in 1906 for their extensive observations, descriptions, and categorizations of neurons throughout the brain. While Luigi Galvani's pioneering work in the late 1700s had set the stage for studying the electrical excitability of muscles and neurons, it was in the late 19th century that Emil du Bois-Reymond, Johannes Peter Müller, and Hermann von Helmholtz demonstrated that the electrical excitation of neurons predictably affected the electrical states of adjacent neurons,[19] and Richard Caton found electrical phenomena in the cerebral hemispheres of rabbits and monkeys.

In parallel with this research, work with brain-damaged patients by Paul Broca suggested that certain regions of the brain were responsible for certain functions. At the time, Broca's findings were seen as a confirmation of Franz Joseph Gall's theory that language was localized and that certain psychological functions were localized in specific areas of the cerebral cortex.[20][21] The localization of function hypothesis was supported by observations of epileptic patients conducted by John Hughlings Jackson, who correctly inferred the organization of the motor cortex by watching the progression of seizures through the body. Carl Wernicke further developed the theory of the specialization of specific brain structures in language comprehension and production. Modern

research through neuroimaging techniques, still uses the Brodmann cerebral cytoarchitectonic map (referring to study of cell structure) anatomical definitions from this era in continuing to show that distinct areas of the cortex are activated in the execution of specific tasks.[22]

During the 20th century, neuroscience began to be recognized as a distinct academic discipline in its own right, rather than as studies of the nervous system within other disciplines. Eric Kandel and collaborators have cited David Rioch, Francis O. Schmitt, and Stephen Kuffler as having played critical roles in establishing the field.[23] Rioch originated the integration of basic anatomical and physiological research with clinical psychiatry at the Walter Reed Army Institute of Research, starting in the 1950s. During the same period, Schmitt established a neuroscience research program within the Biology Department at the Massachusetts Institute of Technology, bringing together biology, chemistry, physics, and mathematics. The first freestanding neuroscience department (then called Psychobiology) was founded in 1964 at the University of California, Irvine by James L. McGaugh.[*citation needed*] This was followed by the Department of Neurobiology at Harvard Medical School which was founded in 1966 by Stephen Kuffler.[24]

The understanding of neurons and of nervous system function became increasingly precise and molecular during the 20th century. For example, in 1952, Alan Lloyd Hodgkin and Andrew Huxley presented a mathematical model for transmission of electrical signals in neurons of the giant axon of a squid, which they called "action potentials", and how they are initiated and propagated, known as the Hodgkin–Huxley model. In 1961–1962, Richard FitzHugh and J. Nagumo simplified Hodgkin–Huxley, in what is called the FitzHugh–Nagumo model. In 1962, Bernard Katz modeled neurotransmission across the space between neurons known as synapses. Beginning in 1966, Eric Kandel and collaborators examined biochemical changes in neurons associated with learning and memory storage in *Aplysia*. In 1981 Catherine Morris and Harold Lecar combined these models in the Morris–Lecar model. Such increasingly quantitative work gave rise to numerous biological neuron models.

Modern neuroscience

Main article: Outline of neuroscience

The scientific study of the nervous system has increased significantly during the second half of the twentieth century, principally due to advances in molecular biology, electrophysiology, and computational neuroscience. This has allowed neuroscientists to study the nervous system in all its aspects: how it is structured, how it works, how it develops, how it malfunctions, and how it can be changed. For example, it has become possible to understand, in much detail, the complex processes occurring within a single neuron. Neurons are cells specialized for communication. They are able to communicate with neurons and other cell types through specialized junctions called synapses, at which electrical or electrochemical signals can be transmitted from one cell to another. Many neurons extrude a long thin filament of axoplasm called an axon, which may extend to distant parts of the body and are capable of rapidly carrying electrical signals, influencing the activity of other neurons, muscles, or glands at their termination points. A nervous system emerges from the assemblage of neurons that are connected to each other.

In vertebrates, the nervous system can be split into two parts, the central nervous system (brain and spinal cord), and the peripheral nervous system. In many species — including all vertebrates — the nervous system is the most complex organ system in the body, with most of the complexity residing in the brain. The human brain alone contains around one hundred billion neurons and one hundred trillion synapses; it consists of thousands of distinguishable substructures, connected to each other in synaptic networks whose intricacies have only begun to be unraveled. The majority of the approximately 20,000–25,000 genes belonging to the human genome are expressed specifically in the brain. Due to the plasticity of the human brain, the structure of its synapses and their resulting functions change throughout life.[25] Thus the challenge of making sense of all this complexity is formidable.

Molecular and cellular neuroscience

Main articles: Molecular neuroscience and Cellular neuroscience

The study of the nervous system can be done at multiple levels, ranging from the molecular and cellular levels to the systems and cognitive levels. At the molecular level, the basic questions addressed in molecular neuroscience include the mechanisms by which neurons express and respond to molecular signals and how axons form complex connectivity patterns. At this level, tools from molecular biology and genetics are used to understand how neurons develop and how genetic changes affect biological functions. The morphology, molecular identity, and physiological characteristics of neurons and how they relate to different types of behavior are also of considerable interest.

The fundamental questions addressed in cellular neuroscience include the mechanisms of how neurons process signals physiologically and electrochemically. These questions include how signals are processed by neurites – thin extensions from a neuronal cell body, consisting of dendrites (specialized to receive synaptic inputs from other neurons) and axons (specialized to conduct nerve impulses called action potentials) – and somas (the cell bodies of the neurons containing the nucleus), and how neurotransmitters and electrical signals are used to process information in a neuron. Another major area of neuroscience is directed at investigations of the development of the nervous system. These questions include the patterning and regionalization of the nervous system, neural stem cells, differentiation of neurons and glia, neuronal migration, axonal and dendritic development, trophic interactions, and synapse formation.

Computational neurogenetic modeling is concerned with the development of dynamic neuronal models for modeling brain functions with respect to genes and dynamic interactions between genes.

Neural circuits and systems

Main articles: Biological neural network and Systems neuroscience

At the systems level, the questions addressed in systems neuroscience include how biological neural networks or neural circuits are formed and used anatomically and physiologically to produce functions such as reflexes, multisensory integration, motor coordination, circadian rhythms, emotional responses, learning, and memory. In other words, they address how these neural circuits function and the mechanisms through which behaviors are generated. For example, systems level analysis addresses questions concerning specific sensory and motor modalities: how does vision work? How do songbirds learn new songs and bats localize with ultrasound? How does the somatosensory system process tactile information? The related fields of neuroethology and neuropsychology address the question of how neural substrates underlie specific animal and human behaviors. Neuroendocrinology and psychoneuroimmunology examine interactions between the nervous system and the endocrine and immune systems, respectively. Despite many advancements, the way that networks of neurons perform complex cognitive processes and behaviors is still poorly understood.

TOC Previous Next

Cognitive and behavioral neuroscience

Main article: Cognitive neuroscience

At the cognitive level, cognitive neuroscience addresses the questions of how psychological functions are produced by neural circuitry. The emergence of powerful new measurement techniques such as neuroimaging (e.g., fMRI, PET, SPECT), electrophysiology, and human genetic analysis combined with sophisticated experimental techniques from cognitive psychology allows neuroscientists and

psychologists to address abstract questions such as how human cognition and emotion are mapped to specific neural substrates. Although many studies still hold a reductionist stance looking for the neurobiological basis of cognitive phenomena, recent research shows that there is an interesting interplay between neuroscientific findings and conceptual research, soliciting and integrating both perspectives. For example, the neuroscience research on empathy solicited an interesting interdisciplinary debate involving philosophy, psychology and psychopathology.[26] Moreover, the neuroscientific identification of multiple memory systems related to different brain areas has challenged the idea of memory as a literal reproduction of the past, supporting a view of memory as a generative, constructive and dynamic process.[27]

Neuroscience is also allied with the social and behavioral sciences as well as nascent interdisciplinary fields such as neuroeconomics, decision theory, social neuroscience, and neuromarketing to address complex questions about interactions of the brain with its environment. A study into consumer responses for example uses EEG to investigate neural correlates associated with narrative transportation into stories about energy efficiency.[28]

Ultimately neuroscientists would like to understand every aspect of the nervous system, including how it works, how it develops, how it malfunctions, and how it can be altered or repaired. The specific topics that form the main foci of research change over time, driven by an ever-expanding base of knowledge and the availability of increasingly sophisticated technical methods. Over the long term, improvements in technology have been the primary drivers of progress. Developments in electron microscopy, computers, electronics, functional brain imaging, and most recently genetics and genomics, have all been major drivers of progress.

TOC Previous Next

Insufficient study sizes

Most studies in neurology have too few test subjects to be scientifically

sure. Those insufficient size studies are the basis for all domain-specific diagnoses in neuropsychiatry, since the few large enough studies there are always find individuals with the brain changes thought to be associated with a mental condition but without any of the symptoms. The only diagnoses that can be validated through large enough brain studies are those on serious brain damages and neurodegenerative diseases that destroy most of the brain.[29][30]

TOC Previous Next

Translational research and medicine

Further information: Translational research

Neurology, psychiatry, neurosurgery, psychosurgery, anesthesiology and pain medicine, neuropathology, neuroradiology, ophthalmology, otolaryngology, clinical neurophysiology, addiction medicine, and sleep medicine are some medical specialties that specifically address the diseases of the nervous system. These terms also refer to clinical disciplines involving diagnosis and treatment of these diseases. Neurology works with diseases of the central and peripheral nervous systems, such as amyotrophic lateral sclerosis (ALS) and stroke, and their medical treatment. Psychiatry focuses on affective, behavioral, cognitive, and perceptual disorders. Anesthesiology focuses on perception of pain, and pharmacologic alteration of consciousness. Neuropathology focuses upon the classification and underlying pathogenic mechanisms of central and peripheral nervous system and muscle diseases, with an emphasis on morphologic, microscopic, and chemically observable alterations. Neurosurgery and psychosurgery work primarily with surgical treatment of diseases of the central and peripheral nervous systems. The boundaries between these specialties have been blurring recently as they are all influenced by basic research in neuroscience. Brain imaging also enables objective, biological insights into mental illness, which can lead to faster diagnosis, more accurate prognosis, and help assess patient progress over time.[31]

Integrative neuroscience makes connections across these specialized areas of focus.

Major branches

Modern neuroscience education and research activities can be very roughly categorized into the following major branches, based on the subject and scale of the system in examination as well as distinct experimental or curricular approaches. Individual neuroscientists, however, often work on questions that span several distinct subfields.

TOC Previous Next

Neuroscience organizations

The largest professional neuroscience organization is the Society for Neuroscience (SFN), which is based in the United States but includes many members from other countries. Since its founding in 1969 the SFN has grown steadily: as of 2010 it recorded 40,290 members from 83 different countries.[35] Annual meetings, held each year in a different American city, draw attendance from researchers, postdoctoral fellows, graduate students, and undergraduates, as well as educational institutions, funding agencies, publishers, and hundreds of businesses that supply products used in research.

Other major organizations devoted to neuroscience include the International Brain Research Organization (IBRO), which holds its meetings in a country from a different part of the world each year, and the Federation of European Neuroscience Societies (FENS), which holds a meeting in a different European city every two years. FENS comprises a set of 32 national-level organizations, including the British Neuroscience Association, the German Neuroscience Society (*Neurowissenschaftliche Gesellschaft*), and the French *Société des Neurosciences*. The first National Honor Society in Neuroscience, Nu Rho Psi, was founded in 2006.

In 2013, the BRAIN Initiative was announced in the US.

TOC Previous Next

Public education and outreach

In addition to conducting traditional research in laboratory settings, neuroscientists have also been involved in the promotion of awareness and knowledge about the nervous system among the general public and government officials. Such promotions have been done by both individual neuroscientists and large organizations. For example, individual neuroscientists have promoted neuroscience education among young students by organizing the International Brain Bee, which is an

academic competition for high school or secondary school students worldwide.[36] In the United States, large organizations such as the Society for Neuroscience have promoted neuroscience education by developing a primer called Brain Facts,[37] collaborating with public school teachers to develop Neuroscience Core Concepts for K-12 teachers and students,[38] and cosponsoring a campaign with the Dana Foundation called Brain Awareness Week to increase public awareness about the progress and benefits of brain research.[39] In Canada, the CIHR Canadian National Brain Bee is held annually at McMaster University.[40]

Finally, neuroscientists have also collaborated with other education experts to study and refine educational techniques to optimize learning among students, an emerging field called educational neuroscience.[41] Federal agencies in the United States, such as the National Institute of Health (NIH)[42] and National Science Foundation (NSF),[43] have also funded research that pertains to best practices in teaching and learning of neuroscience concepts.

TOC Previous Next

See also

- List of neuroscience databases
- List of neuroscience topics
- List of neuroscientists
- Neuroplasticity
- Outline of brain mapping
- Outline of the human brain
- List of regions in the human brain
- Gut–brain axis
- Connectomics

TOC Previous Next

References

1. ^ "Neuroscience". *Merriam-Webster Medical Dictionary*.
2. ^ "Neurobiology". *Dictionary.com*. Retrieved 2017-01-22.
3. ^ Kandel, Eric R. (2012). *Principles of Neural Science, Fifth Edition*. McGraw-Hill Education. pp. I. Overall perspective. ISBN 978-0071390118.
4. ^ Ayd, Frank J., Jr. (2000). *Lexicon of Psychiatry, Neurology and the Neurosciences*. Lippincott, Williams & Wilkins. p. 688. ISBN 0781724686.
5. ^ Shulman, Robert G. (2013). "Neuroscience: A Multidisciplinary, Multilevel Field". *Brain Imaging: What it Can (and Cannot) Tell Us About Consciousness*. Oxford University Press. p. 59. ISBN 9780199838721.
6. ^ Ogawa, Hiroto; Oka, Kotaro (2013). *Methods in Neuroethological Research*. Springer. p. v. ISBN 9784431543305.
7. ^ Tanner, Kimberly D. (2006-01-01). "Issues in Neuroscience Education: Making Connections". *CBE— Life Sciences Education*. **5** (2): 85. doi:10.1187/cbe.06-04-0156. ISSN 1931-7913. PMC 1618510 .
8. ^ Kandel, Eric R. (2012). *Principles of Neural Science, Fifth Edition*. McGraw-Hill Education. p. 5. ISBN 978-0071390118. "The last frontier of the biological sciences – their ultimate challenge – is to understand the biological basis of consciousness and the mental processes by which we perceive, act, learn, and remember."
9. ^ Zull, J. (2002). *The art of changing the brain: Enriching the practice of teaching by exploring the biology of learning*. Sterling, Virginia: Stylus Publishing, LLC
10. ^ "History of IBRO". *International Brain Research Organization*. 2010.[*dead link*]
11. ^ The Beginning Archived April 21, 2012, at the Wayback Machine., International Society for Neurochemistry
12. ^ "About EBBS". *European Brain and Behaviour Society*. 2009. Archived from the original on 2016-03-03.
13. ^ "About SfN". *Society for Neuroscience*.
14. ^ Mohamed W (2008). "The Edwin Smith Surgical Papyrus: Neuroscience in Ancient Egypt". *IBRO History of Neuroscience*. Retrieved 2014-07-06.
15. ^ Herodotus (2009) [440 BCE]. *The Histories: Book II (Euterpe)*. Translated by George Rawlinson.
16. ^ Plato (2009) [360 BCE]. *Timaeus*. Translated by George Rawlinson.
17. ^ Finger, Stanley (2001). *Origins of Neuroscience: A History of Explorations into Brain Function* (3rd ed.). New York: Oxford University Press, USA. pp. 3–17. ISBN 0-19-514694-8.
18. ^ Guillery, R (Jun 2005). "Observations of synaptic structures: origins of the neuron doctrine

and its current status". *Philos Trans R Soc Lond B Biol Sci*. **360** (1458): 1281–307. doi:10.1098/rstb.2003.1459. PMC 1569502 . PMID 16147523.

19. ^ Harrison, David W. (2015). *Brain Asymmetry and Neural Systems Foundations in Clinical Neuroscience and Neuropsychology*. Springer International Publishing. pp. 15–16. ISBN 978-3-319-13068-2.
20. ^ Greenblatt SH (1995). "Phrenology in the science and culture of the 19th century". *Neurosurg*. **37** (4): 790–805. doi:10.1227/00006123-199510000-00025. PMID 8559310.
21. ^ Bear MF; Connors BW; Paradiso MA (2001). *Neuroscience: Exploring the Brain* (2nd ed.). Philadelphia: Lippincott Williams & Wilkins. ISBN 0-7817-3944-6.
22. ^ Kandel ER; Schwartz JH; Jessel TM (2000). *Principles of Neural Science* (4th ed.). New York: McGraw-Hill. ISBN 0-8385-7701-6.
23. ^ Cowan, W.M.; Harter, D.H.; Kandel, E.R. (2000). "The emergence of modern neuroscience: Some implications for neurology and psychiatry". *Annual Review of Neuroscience*. **23**: 345–346. doi:10.1146/annurev.neuro.23.1.343. PMID 10845068.
24. ^ "History - Department of Neurobiology".
25. ^ The United States Department of Health and Human Services. Mental Health: A Report of the Surgeon General. "Chapter 2: The Fundamentals of Mental Health and Mental Illness" pp 38 [1] Retrieved May 21, 2012
26. ^ Aragona M, Kotzalidis GD, Puzella A. (2013) The many faces of empathy, between phenomenology and neuroscience. Archives of Psychiatry and Psychotherapy, 4:5-12 http://www.archivespp.pl/uploads/images/2013_15_4/5Aragona_APP_4_2013.pdf
27. ^ Ofengenden, Tzofit (2014). "Memory formation and belief" (PDF). *Dialogues in Philosophy, Mental and Neuro Sciences*. **7** (2): 34–44.
28. ^ Gordon, R., Ciorciari, J., & van Laer, T. (2017). "Using EEG to examine the role of attention, working memory, emotion, and imagination in narrative transportation." *European Journal of Marketing*. Available at SSRN: https://ssrn.com/abstract=2892967 or doi: https://doi.org/10.1108/EJM-12-2016-0881
29. ^ K. Button et al. "Power failure: why small sample size undermines the reliability of neuroscience", Nature Reviews Neuroscience 2013
30. ^ Fang, Steen och Casadevall, "Misconduct accounts for the majority of retracted scientific publications", PNAS 2012.
31. ^ Lepage M (2010). "Research at the Brain Imaging Centre". *Douglas Mental Health University Institute*. Archived from the original on March 5, 2012.
32. ^ Panksepp J (1990). "A role for "affective neuroscience" in understanding stress: the case of separation distress circuitry". In Puglisi-Allegra S; Oliverio A. *Psychobiology of Stress*.

Dordrecht, Netherlands: Kluwer Academic. pp. 41–58. ISBN 0-7923-0682-1.
33. ^ Chiao, J.Y. & Ambady, N. (2007). Cultural neuroscience: Parsing universality and diversity across levels of analysis. In Kitayama, S. and Cohen, D. (Eds.) Handbook of Cultural Psychology, Guilford Press, New York, pp. 237-254.
34. ^ 1933-, Shepherd, Gordon M.,. *Neurogastronomy : how the brain creates flavor and why it matters*. ISBN 9780231159111. OCLC 882238865.
35. ^ "Financial and organizational highlights" (PDF). Society for Neuroscience. Archived from the original (PDF) on September 15, 2012.
36. ^ "About the International Brain Bee". *The International Brain Bee*.
37. ^ "Brain Facts: A Primer on the Brain and Nervous System". *Society for Neuroscience*.
38. ^ "Neuroscience Core Concepts: The Essential Principles of Neuroscience". *Society for Neuroscience*. Archived from the original on April 15, 2012.
39. ^ "Brain Awareness Week Campaign". *The Dana Foundation*.
40. ^ "Official CIHR Canadian National Brain Bee Website". Archived from the original on May 30, 2014. Retrieved 24 September 2014.
41. ^ Goswami U (2004). "Neuroscience, education and special education". *Br J of Spec Educ*. **31** (4): 175–183. doi:10.1111/j.0952-3383.2004.00352.x.
42. ^ "The SEPA Program". NIH. Archived from the original on September 20, 2011. Retrieved September 23, 2011.
43. ^ "About Education and Human Resources". NSF. Retrieved September 23, 2011.
TOC | ← Previous | Next →

Further reading

- Bear, M. F.; B. W. Connors; M. A. Paradiso (2006). *Neuroscience: Exploring the Brain* (3rd ed.). Philadelphia: Lippincott. ISBN 0-7817-6003-8.
- Binder, Marc D.; Hirokawa, Nobutaka; Windhorst, Uwe, eds. (2009). *Encyclopedia of Neuroscience*. Springer. ISBN 978-3-540-23735-8.
- Kandel, ER; Schwartz JH; Jessell TM (2012). *Principles of Neural Science* (5th ed.). New York: McGraw-Hill. ISBN 0-8385-7701-6.
- Squire, L. *et al.* (2012). *Fundamental Neuroscience, 4th edition*. Academic Press; ISBN 0-12-660303-0
- Byrne and Roberts (2004). *From Molecules to Networks*. Academic Press; ISBN 0-12-148660-5
- Sanes, Reh, Harris (2005). *Development of the Nervous System, 2nd edition*. Academic Press; ISBN 0-12-618621-9
- Siegel *et al.* (2005). *Basic Neurochemistry, 7th edition*. Academic Press; ISBN 0-12-088397-X
- Rieke, F. *et al.* (1999). *Spikes: Exploring the Neural Code*. The MIT Press; Reprint edition ISBN 0-262-68108-0
- section.47 Neuroscience 2nd ed. Dale Purves, George J. Augustine, David Fitzpatrick, Lawrence C. Katz, Anthony-Samuel LaMantia, James O. McNamara, S. Mark Williams. Published by Sinauer Associates, Inc., 2001.
- section.18 Basic Neurochemistry: Molecular, Cellular, and Medical Aspects 6th ed. by George J. Siegel, Bernard W. Agranoff, R. Wayne Albers, Stephen K. Fisher, Michael D. Uhler, editors. Published by Lippincott, Williams & Wilkins, 1999.
- Andreasen, Nancy C. (March 4, 2004). *Brave New Brain: Conquering Mental Illness in the Era of the Genome*. Oxford University Press. ISBN 978-0-19-514509-0. Archived from the original on February 24, 2007.
- Damasio, A. R. (1994). *Descartes' Error: Emotion, Reason, and the Human Brain.* New York, Avon Books. ISBN 0-399-13894-3 (Hardcover) ISBN 0-380-72647-5 (Paperback)
- Gardner, H. (1976). *The Shattered Mind: The Person After Brain Damage.* New York, Vintage Books, 1976 ISBN 0-394-71946-8
- Goldstein, K. (2000). *The Organism.* New York, Zone Books. ISBN 0-942299-96-5 (Hardcover) ISBN 0-942299-97-3 (Paperback)
- Lauwereyns, Jan (February 2010). *The Anatomy of Bias: How Neural Circuits Weigh the Options*. Cambridge, Massachusetts: The MIT Press. ISBN 0-262-12310-X.

- Subhash Kak, The Architecture of Knowledge: Quantum Mechanics, Neuroscience, Computers and Consciousness, Motilal Banarsidass, 2004, ISBN 81-87586-12-5
- Llinas R. (2001). *I of the Vortex: From Neurons to Self* MIT Press. ISBN 0-262-12233-2 (Hardcover) ISBN 0-262-62163-0 (Paperback)
- Luria, A. R. (1997). *The Man with a Shattered World: The History of a Brain Wound.* Cambridge, Massachusetts, Harvard University Press. ISBN 0-224-00792-0 (Hardcover) ISBN 0-674-54625-3 (Paperback)
- Luria, A. R. (1998). *The Mind of a Mnemonist: A Little Book About A Vast Memory.* New York, Basic Books, Inc. ISBN 0-674-57622-5
- Medina, J. (2008). *Brain Rules: 12 Principles for Surviving and Thriving at Work, Home, and School.* Seattle, Pear Press. ISBN 0-9797777-0-4 (Hardcover with DVD)
- Pinker, S. (1999). *How the Mind Works.* W. W. Norton & Company. ISBN 0-393-31848-6
- Pinker, S. (2002). *The Blank Slate: The Modern Denial of Human Nature.* Viking Adult. ISBN 0-670-03151-8
- Robinson, D. L. (2009). *Brain, Mind and Behaviour: A New Perspective on Human Nature* (2nd ed.). Dundalk, Ireland: Pontoon Publications. ISBN 978-0-9561812-0-6.
- Penrose, R., Hameroff, S. R., Kak, S., & Tao, L. (2011). Consciousness and the universe: Quantum physics, evolution, brain & mind. Cambridge, MA: Cosmology Science Publishers.
- Ramachandran, V. S. (1998). *Phantoms in the Brain*. New York, HarperCollins. ISBN 0-688-15247-3 (Paperback)
- Rose, S. (2006). *21st Century Brain: Explaining, Mending & Manipulating the Mind* ISBN 0-09-942977-2 (Paperback)
- Sacks, O. *The Man Who Mistook His Wife for a Hat*. Summit Books ISBN 0-671-55471-9 (Hardcover) ISBN 0-06-097079-0 (Paperback)
- Sacks, O. (1990). *Awakenings.* New York, Vintage Books. (See also Oliver Sacks) ISBN 0-671-64834-9 (Hardcover) ISBN 0-06-097368-4 (Paperback)
- Encyclopedia:Neuroscience Scholarpedia Expert articles
- Sternberg, E. (2007) *Are You a Machine? The Brain, the Mind and What it Means to be Human.* Amherst, New York: Prometheus Books.
- Churchland, P. S. (2011) *Braintrust: What Neuroscience Tells Us about Morality*. Princeton University Press. ISBN 0-691-13703-X
- Selvin, Paul (2014) "Hot Topics presentation: New Small Quantum Dots for Neuroscience". SPIE Newsroom, doi: 10.1117/2.3201403.17

External links

- Neuroscience on *In Our Time* at the BBC.
- Neuroscience Information Framework (NIF)
- Neurobiology at Curlie (based on DMOZ)
- American Society for Neurochemistry
- British Neuroscience Association (BNA)
- Federation of European Neuroscience Societies
- Neuroscience Online (electronic neuroscience textbook)
- HHMI Neuroscience lecture series - *Making Your Mind: Molecules, Motion, and Memory*
- *Société des Neurosciences*
- Neuroscience For Kids

Categories: Neuroscience

This page was last edited on 7 June 2018, at 16:47.

Back to main TOC

Contents

Umoove

Jump to navigation Jump to search

Umoove is a high tech startup company that has developed and patented a software-only face and eye tracking technology. The idea was first conceived as an attempt to aid disabled people but has since evolved. The only compatibility qualification for tablet computers and smartphones to run Umoove software is a front-facing camera. Umoove headquarters are in Israel on Jerusalem's Har Hotzvim.

Umoove has 15 employees and received two million dollars in financing in 2012. The company's original founders invested around $800,000 to start the business in 2010.[3] In 2013 Umoove was named one of the top three most promising Israeli start ups by Newsgeeks magazine.[4] The company also participated in the 2013 LeWeb conference in Paris, France, where innovative technology startups are showcased.[5]

TOP

TOC Next

Technology

The technology uses information extracted from previous frames, such as the angle of the user’s head to predict where to look for facial targets in the next frame. This anticipation minimizes the amount of computation needed to scan each image.[6] Umoove accounts for variances in environment, lighting conditions and user hand shake/movement. The technology is designed to provide a consistent experience, whether you’re in a brightly lit area or a darkened basement, and to work fluidly between them by adapting its processing when it detects color and brightness shifts. It uses an active stabilization technique to filter out natural body movements from an unstable camera in order to minimize false-positive motion detection.[7]

Running the Umoove software on a Samsung Galaxy S3 is said to take up only 2% CPU.[6] Umoove works exclusively with software and there is no hardware add-on necessary. It can be run on any smartphone or tablet computer that has a front-facing camera. Umoove claims that even a low-quality camera on an old device will run their software flawlessly.

Umoove Experience

In January 2014 Umoove released its first game onto the app store.[8] The Umoove Experience game lets users control where they are 'flying' in the game through simple gestures and motions with their head. The avatar will basically go toward wherever the user looks.[9] The game was created to showcase the technology for game developers[10] but that did not stop some from criticizing its simplicity.[11] Umoove also announced that they raised another one million dollars and that they are opening offices in Silicon Valley, California.[1]

In February 2014, Umoove announced that their face-tracking software development kit is available for Android developers as well as iOS.[12]

Reviews

The Umoove Experience garnered mostly positive reviews[13] from bloggers and mainstream media with some predicting that it could be the future of mobile gaming.[9] Mashable wrote that Umoove’s technology could be the emergence of gesture recognition technology in the mobile space, similar to Kinect with console gaming and what Leap Motion has done with desktop computers.[14]

Some, however, remain skeptical. CNET, for example, did not give the game a positive review and called the eye tracking technology ‘freaky but cool’. They also noted that pioneering technologies have been known to fall short of expectations, citing Apple Inc’s Siri as an example. The technology blog GigaOM said that the Umoove Experience is ’awesome’[13] and technology evangelist Robert Scoble has called Umoove "brilliant".[15]

TOC | Previous | Next

uHealth

In January 2015, Umoove released uHealth, an mobile application that uses eye tracking game-like exercise to challenge the user's ability to be attentive, continuously focus, follow commands and avoid distractions. The app is designed in the form of two games, one to improve attention and another that hones focus.[16] uHealth is a training tool, not a diagnostic. Umoove has stated that they want to use their technology for diagnosing neurological disorders but this will depend on clinical tests and FDA approval.[17] The company cites the direct relationship between eye movements and brain activity as well as various vision based therapies have been backed by many scientific studies conducted over the past decades. uHealth is the first time this type of therapy is delivered right to the end user through a simple download.[18]

Collaboration rumors

In March 2013 there were rumors on the internet that Umoove would be the functioning software embedded into the Samsung Galaxy S4, which was due to launch that month. This rumor was perpetrated by, among others, New York Times,[3] Techcrunch[7] and Yahoo.[19] Once Samsung launched without the Umoove technology rumors about a potential collaboration with Apple Inc hit the web. It has been said that due to the fact that Apple Inc is losing market share and stock value to Samsung they will be more aggressive and eye tracking is a logical place to make that move.[20]

TOC Previous

References

1. ^ a b "GeekTime". Retrieved 18 February 2014.
2. ^ "SpectrumWebsite". Retrieved 11 September 2013.
3. ^ a b "NewYorkTimes". Retrieved 11 September 2013.
4. ^ "Israel21C". Retrieved 11 September 2013.
5. ^ "LeWebsite". Retrieved 18 February 2014.
6. ^ a b "SpectrumWebsite". Retrieved 12 September 2013.
7. ^ a b "TechCrunch". Retrieved 12 September 2013.
8. ^ "iTunes". Retrieved 18 February 2014.
9. ^ a b "BGRwebsite". Retrieved 18 February 2014.
10. ^ "TUAWWEBSITE". Retrieved 18 February 2014.
11. ^ "CNETWEBSITE". Retrieved 18 February 2014.
12. ^ "TechCrunchFeb14". Retrieved 20 February 2014.
13. ^ a b "Gigaom". Retrieved 19 February 2014.
14. ^ "Mashable". Retrieved 18 February 2014.
15. ^ "ScoblePlus". Retrieved 12 September 2013.
16. ^ "CTV". Retrieved 17 February 2015.
17. ^ "TimesofIsraelShamah". Retrieved 17 February 2015.
18. ^ "RapidNewsNetwork". Retrieved 17 February 2015.
19. ^ "Yahoo". Retrieved 12 September 2013.
20. ^ "TimesofIsrael". Retrieved 12 September 2013.

Categories:

- Companies established in 2010
- Software companies of Israel
- Object recognition and categorization
- Computer vision
- Cognitive science
- Gesture recognition

Contents

Cognitive Theory of Inquiry Teaching

Jump to navigation Jump to search

The **Cognitive Theory of Inquiry Teaching**, also referred to as the **Cognitive Theory of Interactive Teaching**, was developed by Allan Collins and Albert L. Stevens (Collins & Stevens, 1981). Allan Collins was a chief scientist at Bolt Beranek and Newman Inc., a research firm in Cambridge Massachusetts. He is also a specialist in the field of cognitive science and human semantic processing. Albert L. Stevens was a senior scientist at Bolt Beranek and Newman Inc. He was also director of the company's Artificial Intelligence, Education Technology and Training Systems Division. He is also a specialist in cognitive science. (Reigeluth, 1983) The Cognitive Theory of Inquiry Teaching according to Collins and Stevens (1981) requires the learner to construct theories and principles through dialogue, the teaching of self-questioning techniques and the teaching of metacognitive or self-monitoring skills, all with the intent of clarifying misconceptions so the theory or principle is well articulated and developed. The essence of the cognitive theory of Inquiry teaching is that of developing students' metacognitive skills. Inquiry teaching deliberately attempts to develop these stills through instruction.

The theory is a prescriptive model rooted in the discovery tradition and cognitive sciences. It was derived form an analysis of the transcripts of teachers, described as interactive teachers, using a variety of teaching strategies. These strategies were in some way related to one of the following methodology: the inquiry method of the teaching, discovery method of teaching and Socratic method of teaching. The transcripts studied represent a variety of topics taught by teachers across different subject areas (Reigeluth, 1983). Collins and Stevens believed that their Cognitive Theory of Inquiry Teaching is domain independent or that it can be applied across subject areas or the curriculum.

TOP

Historical background

Inquiry teaching is rooted in the didactic methodologies of the ancient Greek. According Mayer and Alexander (2011), inquiry teaching is rooted in the didactic methodology of the ancient Greek, where the teacher poses a problem and assists the student in solving that problem by asking a series of question. They have also pointed out that this method of instruction can be seen in the works of Plato and Socrates. Bransford, Franks and Sherwood (1989), as cited by Mayer and Alexander (2011), have indicated that it was not until the 1960s that the role of teachers started to change from where the teacher provided the student with the questions as well as the answers. After the 1960s, instruction provided greater opportunity for students to engage in creating their own answers to questions posed (Mayer & Alexander, 2011).

TOC Previous Next

Characteristics

The purpose of the Cognitive Theory of Inquiry Teaching according to Collins (1986) is to provide learners with the opportunity to “actively engage in articulating theories and principles that are critical to deep understanding of a domain” (p.1). Collins (1986) believes that the knowledge attained will allow the learner to actively and meaningfully engage in solving problems and making predictions. He also indicated that the knowledge acquire is not simply content knowledge. Figure 1 summarizes Collins and Stevens Theory of Inquiry Teaching.

The Cognitive Theory of Inquiry (Interactive) Teaching according to the Reigeluth (1983) consists of three parts:

1. The teachers goals
2. The teaching strategies employed by teachers
3. The controlling structures used to govern their teaching.

There are two main goals teachers using the inquiry method seek to achieve, according to Collin and Stevens (1981):

1. The teaching of a particular rule or theory
2. Teaching students how to derive the rule or theory.

These two main goals are associated with several sub-goals. The list below identifies the two main goals and their associated sub-goal as posited by Collins and Stevens (1981):

1. The teaching of a particular rule or theory
    - Analyzing and addressing misconceptions of students hypotheses
    - Students are taught how to make prediction in new situations
2. Teaching students how to derive the rule or theory
    - Students are taught what questions to ask
    - Students are taught the nature of the theory or rule
    - Students are taught how to test the rule or theory
    - Student are taught how to articulate and defend the rule or theory

Teaching strategies employed by teachers

Collins and Stevens (1981) have highlighted ten teaching strategies used by teachers using inquiry teaching. They believed that these ten teaching strategies, listed below, are the most important ones identified in their investigation. These ten teaching strategies identified by Collin and Stevens (1981, p. 18) are:

1. Selecting positive and negative exemplars
2. Varying cases systematically
3. Selecting counterexamples
4. Generating hypothetical cases
5. Forming hypotheses
6. Testing hypotheses
7. Considering alternative predictions
8. Entrapping students
9. Tracing consequences to a contradiction
10. Questioning authority

TOC Previous Next

Controlling structures used to govern their teaching

Colling and Stevens (1981) indicated that the time allocated between the teachers' goals and sub-goals is critical to the effectiveness of inquiry teaching. Collins and Stevens (1977), as cited by Collins and Stevens (1981) had made an attempt at developing a theory of controlling structures after getting feedback from several tutors. This controlling structure theory consisted of four parts. The four parts this theory includes the following:

1. "a set of strategies for selecting cases with respect to the main goals,
2. a student model,
3. an agenda,
4. a set of priority rules for adding goals and sub-goals to the agenda." (p. 47)

Collins and Stevens (1981) have suggested that base on the goals of the teacher, cases are selected to ensure that student develop mastery of the principles or theories being taught. They have also indicated that teachers appear to develop some strategies for selecting cases to develop students' mastery of the principles or theories. These are some of the strategies used by teachers for selecting cases as mentioned by Collins and Stevens (1981):

1. cases that demonstrated the more important factors were selected before those that have less important factors
2. the cases selected were sequenced from concrete factors to abstract factors
3. the selection of cases dependent on their importance and frequency: more important or frequent to less important and less frequent

According to Collins and Stevens the controlling structure used to govern the dialogue in the Cognitive Theory of Inquiry Teaching is demonstrated in the following manner:

1. A case is chosen, which is a theory or principle, based on the main goal of the teacher. The teacher then questions students to determine their understanding of the theory. Students' answers reveal their understanding or lack of understanding. Next, the teacher tags the theory or principle based what students know, their error and what they do not know. Collins and Stevens referred to this as the students' model.
2. Armed with the students' model, the teacher can then add information to facilitate and improve students understanding of what is known. This is determined by the level of sophistication of students' answers.
3. Sub-goals are developed to diagnose and address students' errors and misconceptions.
4. An agenda is developed prioritizing how students' errors and misconception well be address using the sub-goals developed.

Collins and Stevens (1977), as cited in Collins and Stevens (1981), have identified how priorities have been set by teachers. Priorities have been set based on the following:

1. "Errors before omissions.
2. Prior steps before later steps.
3. Shorter fixes before longer fixes.
4. More important factors before less important factors" (p. 49)

Criticism of the Cognitive Theory of Inquiry Teaching Reigeluth (1983) has put forward the following criticisms about Cognitive Theory of Inquiry:

1. He believes that the theory is not suitable for all kinds of content as proposed by Collins and Stevens (1981), who believed that the theory is domain independent and that it can be used to facilitate the development of rules and theories needed for deep understand of the domain. The theory, as he indicated, is more applicable to instruction involving the construction or understanding of rules, principles and theories. The theory may not be suitable for the teaching of facts or concept.
2. He believes that the theory is not self-sufficient, in that it requires the use of other forms of instruction to facilitate the development students

background information, which is critical to the discovery process proposed by Collins and Stevens (1981)

3. The theory may not be efficient in specific rules and principle, particularly those involving algorithms, where an expository approach may be more efficient.

TOC Previous Next

Conclusion

The Collins and Stevens Cognitive Theory of Inquiry Teaching, despite the short coming identified by Reigeluth (1983), provides some strategies for teaching high-order thinking skills. Reigeluth (1983) also points out that the Collins and Stevens Cognitive Theory of Teaching provides some strategies for instruction that other theories have overlooked. Strategies such as considering alternative prediction, entrapping students, tracing consequences to a contradiction and questioning authority are invaluable skill in critical thinking. The focus of education today is to develop learners who are independent critical thinkers. There was once the belief that critical thinking skills could not be taught and that these skills develop naturally independent of instruction. The Collins and Stevens Cognitive Theory of Inquiry of Teaching indicate that learners can be taught strategies to develop and apply critical thinking skills. Dewey (1938), as cited by McGregor (2007), pointed out that if students are provided with factual information without the cognitive skills that would enable them to understand, appreciate, transfer and connect ideas, the information gained would become meaningless in the future. It implies therefore, that instruction should seek to nurture the development of critical thinking skill. Dewey (1910) as cited by McGregor (2007), has also indicated that there is a connection between thinking and learning. He posited that "thoughts involved in developing ideas and understandings are often assumed and implicated. To develop thoughtful learning these processes need to be more explicit and connected to the processes of coming to know and understand" (p. 47).

TOC Previous Next

Publications by Allan Collins and Albert L. Stevens

- Collins, A., & Stevens, A. L. (1981). A Cognitive Theory of Interactive Teaching. Cambridge: Bolt Beranek and Newman Inc.
- Collins, A. Processes in acquiring knowledge. In R.C. Anderson, R.J. Spiro, & W.E. Montague (Eds.), Schooling and the acquisition of knowledge. Hillsdale, N.J.: Erlbaum Associates, 1977.
- Collins, A. Explicating the tacit knowledge in teaching and learning. Paper presented at American Educational Research Association, Toronto, 1978.
- Collins, A., & Stevens, A.L. Goals and strategies of effective teachers. To appear in R. Glaser (Ed.), Advances in instructional psychology (Vol. 2). Hillsdale, N.J.: Erlbaum, 1981.

TOC | Previous | Next

See also

- Inquiry-based learning
- Discovering learning
- Problem-based learning
- Project-based learning

TOC Previous

References

- Collins, A. (1986). Different Goals of Inquiry Teaching. Cambridge: Bolt Beranek & Newman Inc.
- Collins, A., & Stevens, A. L. (1981). A Cognitive Theory of Interactive Teaching. Cambridge: Bolt Beranek and Newman Inc.
- Mayer, R. E., & Alexander, P. A. (2011). Handbook of Research on Learning and Learning. New York: Routledge.
- McGregor, D. (2007). Developing Learning: A Guide to Thinking Skills in Education. Berkshire: Open University Press.
- Reigeluth, C. M. (1983). Instructonal-Design Theories and Models: An Overview of Their Current Status. New Jersey: Lawrence Erlbaum Associates, Inc.

Categories:

- Cognitive science

This page was last edited on 15 March 2017, at 07:49.

License

themselves, which together are assembled into a collective whole. A work that constitutes a Collection will not be considered an Adaptation (as defined below) for the purposes of this License.

c. "Creative Commons Compatible License" means a license that is listed at https://creativecommons.org/compatiblelicenses that has been approved by Creative Commons as being essentially equivalent to this License, including, at a minimum, because that license: (i) contains terms that have the same purpose, meaning and effect as the License Elements of this License; and, (ii) explicitly permits the relicensing of adaptations of works made available under that license under this License or a Creative Commons jurisdiction license with the same License Elements as this License.
d. "Distribute" means to make available to the public the original and copies of the Work or Adaptation, as appropriate, through sale or other transfer of ownership.
e. "License Elements" means the following high-level license attributes as selected by Licensor and indicated in the title of this License: Attribution, ShareAlike.
f. "Licensor" means the individual, individuals, entity or entities that offer(s) the Work under the terms of this License.
g. "Original Author" means, in the case of a literary or artistic work, the individual, individuals, entity or entities who created the Work or if no individual or entity can be identified, the publisher; and in addition (i) in the case of a performance the actors, singers, musicians, dancers, and other persons who act, sing, deliver, declaim, play in, interpret or otherwise perform literary or artistic works or expressions of folklore; (ii) in the case of a phonogram the producer being the person or legal entity who first fixes the sounds of a performance or other sounds; and, (iii) in the case of broadcasts, the organization that transmits the broadcast.
h. "Work" means the literary and/or artistic work offered under the terms of this License including without limitation any production in the literary, scientific and artistic domain, whatever may be the mode or form of its expression including digital form, such as a book, pamphlet and other writing; a lecture, address, sermon or other work of the same nature; a dramatic or dramatico-musical work; a choreographic work or entertainment in dumb show; a musical composition with or without

words; a cinematographic work to which are assimilated works expressed by a process analogous to cinematography; a work of drawing, painting, architecture, sculpture, engraving or lithography; a photographic work to which are assimilated works expressed by a process analogous to photography; a work of applied art; an illustration, map, plan, sketch or three-dimensional work relative to geography, topography, architecture or science; a performance; a broadcast; a phonogram; a compilation of data to the extent it is protected as a copyrightable work; or a work performed by a variety or circus performer to the extent it is not otherwise considered a literary or artistic work.

i. "You" means an individual or entity exercising rights under this License who has not previously violated the terms of this License with respect to the Work, or who has received express permission from the Licensor to exercise rights under this License despite a previous violation.
j. "Publicly Perform" means to perform public recitations of the Work and to communicate to the public those public recitations, by any means or process, including by wire or wireless means or public digital performances; to make available to the public Works in such a way that members of the public may access these Works from a place and at a place individually chosen by them; to perform the Work to the public by any means or process and the communication to the public of the performances of the Work, including by public digital performance; to broadcast and rebroadcast the Work by any means including signs, sounds or images.
k. "Reproduce" means to make copies of the Work by any means including without limitation by sound or visual recordings and the right of fixation and reproducing fixations of the Work, including storage of a protected performance or phonogram in digital form or other electronic medium.

2. Fair Dealing Rights.

Nothing in this License is intended to reduce, limit, or restrict any uses free from copyright or rights arising from limitations or exceptions that are provided for in connection with the copyright protection under copyright law or other applicable laws.

3. License Grant.

Subject to the terms and conditions of this License, Licensor hereby grants

You a worldwide, royalty-free, non-exclusive, perpetual (for the duration of the applicable copyright) license to exercise the rights in the Work as stated below:

a. to Reproduce the Work, to incorporate the Work into one or more Collections, and to Reproduce the Work as incorporated in the Collections;
b. to create and Reproduce Adaptations provided that any such Adaptation, including any translation in any medium, takes reasonable steps to clearly label, demarcate or otherwise identify that changes were made to the original Work. For example, a translation could be marked "The original work was translated from English to Spanish," or a modification could indicate "The original work has been modified.";
c. to Distribute and Publicly Perform the Work including as incorporated in Collections; and,
d. to Distribute and Publicly Perform Adaptations.

e. For the avoidance of doubt:

    i. Non-waivable Compulsory License Schemes. In those jurisdictions in which the right to collect royalties through any statutory or compulsory licensing scheme cannot be waived, the Licensor reserves the exclusive right to collect such royalties for any exercise by You of the rights granted under this License;
    ii. Waivable Compulsory License Schemes. In those jurisdictions in which the right to collect royalties through any statutory or compulsory licensing scheme can be waived, the Licensor waives the exclusive right to collect such royalties for any exercise by You of the rights granted under this License; and,
    iii. Voluntary License Schemes. The Licensor waives the right to collect royalties, whether individually or, in the event that the Licensor is a member of a collecting society that administers voluntary licensing schemes, via that society, from any exercise by You of the rights granted under this License.

The above rights may be exercised in all media and formats whether now known or hereafter devised. The above rights include the right to make such modifications as are technically necessary to exercise the rights in other

media and formats. Subject to Section 8(f), all rights not expressly granted by Licensor are hereby reserved.

4. Restrictions.

The license granted in Section 3 above is expressly made subject to and limited by the following restrictions:

a. You may Distribute or Publicly Perform the Work only under the terms of this License. You must include a copy of, or the Uniform Resource Identifier (URI) for, this License with every copy of the Work You Distribute or Publicly Perform. You may not offer or impose any terms on the Work that restrict the terms of this License or the ability of the recipient of the Work to exercise the rights granted to that recipient under the terms of the License. You may not sublicense the Work. You must keep intact all notices that refer to this License and to the disclaimer of warranties with every copy of the Work You Distribute or Publicly Perform. When You Distribute or Publicly Perform the Work, You may not impose any effective technological measures on the Work that restrict the ability of a recipient of the Work from You to exercise the rights granted to that recipient under the terms of the License. This Section 4(a) applies to the Work as incorporated in a Collection, but this does not require the Collection apart from the Work itself to be made subject to the terms of this License. If You create a Collection, upon notice from any Licensor You must, to the extent practicable, remove from the Collection any credit as required by Section 4(c), as requested. If You create an Adaptation, upon notice from any Licensor You must, to the extent practicable, remove from the Adaptation any credit as required by Section 4(c), as requested.
b. You may Distribute or Publicly Perform an Adaptation only under the terms of: (i) this License; (ii) a later version of this License with the same License Elements as this License; (iii) a Creative Commons jurisdiction license (either this or a later license version) that contains the same License Elements as this License (e.g., Attribution-ShareAlike 3.0 US)); (iv) a Creative Commons Compatible License. If you license the Adaptation under one of the licenses mentioned in (iv), you must comply with the terms of that license. If you license the Adaptation under the terms of any of the licenses mentioned in (i), (ii) or (iii) (the "Applicable License"), you must comply with the terms of the

Applicable License generally and the following provisions: (I) You must include a copy of, or the URI for, the Applicable License with every copy of each Adaptation You Distribute or Publicly Perform; (II) You may not offer or impose any terms on the Adaptation that restrict the terms of the Applicable License or the ability of the recipient of the Adaptation to exercise the rights granted to that recipient under the terms of the Applicable License; (III) You must keep intact all notices that refer to the Applicable License and to the disclaimer of warranties with every copy of the Work as included in the Adaptation You Distribute or Publicly Perform; (IV) when You Distribute or Publicly Perform the Adaptation, You may not impose any effective technological measures on the Adaptation that restrict the ability of a recipient of the Adaptation from You to exercise the rights granted to that recipient under the terms of the Applicable License. This Section 4(b) applies to the Adaptation as incorporated in a Collection, but this does not require the Collection apart from the Adaptation itself to be made subject to the terms of the Applicable License.

c. If You Distribute, or Publicly Perform the Work or any Adaptations or Collections, You must, unless a request has been made pursuant to Section 4(a), keep intact all copyright notices for the Work and provide, reasonable to the medium or means You are utilizing: (i) the name of the Original Author (or pseudonym, if applicable) if supplied, and/or if the Original Author and/or Licensor designate another party or parties (e.g., a sponsor institute, publishing entity, journal) for attribution ("Attribution Parties") in Licensor's copyright notice, terms of service or by other reasonable means, the name of such party or parties; (ii) the title of the Work if supplied; (iii) to the extent reasonably practicable, the URI, if any, that Licensor specifies to be associated with the Work, unless such URI does not refer to the copyright notice or licensing information for the Work; and (iv) , consistent with Ssection 3(b), in the case of an Adaptation, a credit identifying the use of the Work in the Adaptation (e.g., "French translation of the Work by Original Author," or "Screenplay based on original Work by Original Author"). The credit required by this Section 4(c) may be implemented in any reasonable manner; provided, however, that in the case of a Adaptation or Collection, at a minimum such credit will appear, if a credit for all contributing authors of the Adaptation or Collection appears, then as

part of these credits and in a manner at least as prominent as the credits for the other contributing authors. For the avoidance of doubt, You may only use the credit required by this Section for the purpose of attribution in the manner set out above and, by exercising Your rights under this License, You may not implicitly or explicitly assert or imply any connection with, sponsorship or endorsement by the Original Author, Licensor and/or Attribution Parties, as appropriate, of You or Your use of the Work, without the separate, express prior written permission of the Original Author, Licensor and/or Attribution Parties.

d. Except as otherwise agreed in writing by the Licensor or as may be otherwise permitted by applicable law, if You Reproduce, Distribute or Publicly Perform the Work either by itself or as part of any Adaptations or Collections, You must not distort, mutilate, modify or take other derogatory action in relation to the Work which would be prejudicial to the Original Author's honor or reputation. Licensor agrees that in those jurisdictions (e.g. Japan), in which any exercise of the right granted in Section 3(b) of this License (the right to make Adaptations) would be deemed to be a distortion, mutilation, modification or other derogatory action prejudicial to the Original Author's honor and reputation, the Licensor will waive or not assert, as appropriate, this Section, to the fullest extent permitted by the applicable national law, to enable You to reasonably exercise Your right under Section 3(b) of this License (right to make Adaptations) but not otherwise.

5. Representations, Warranties and Disclaimer

UNLESS OTHERWISE MUTUALLY AGREED TO BY THE PARTIES IN WRITING, LICENSOR OFFERS THE WORK AS-IS AND MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND CONCERNING THE WORK, EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF TITLE, MERCHANTIBILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT, OR THE ABSENCE OF LATENT OR OTHER DEFECTS, ACCURACY, OR THE PRESENCE OF ABSENCE OF ERRORS, WHETHER OR NOT DISCOVERABLE. SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES, SO SUCH EXCLUSION MAY NOT APPLY TO YOU.

6. Limitation on Liability.

EXCEPT TO THE EXTENT REQUIRED BY APPLICABLE LAW, IN NO EVENT WILL LICENSOR BE LIABLE TO YOU ON ANY LEGAL THEORY FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES ARISING OUT OF THIS LICENSE OR THE USE OF THE WORK, EVEN IF LICENSOR HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

7. Termination

a. This License and the rights granted hereunder will terminate automatically upon any breach by You of the terms of this License. Individuals or entities who have received Adaptations or Collections from You under this License, however, will not have their licenses terminated provided such individuals or entities remain in full compliance with those licenses. Sections 1, 2, 5, 6, 7, and 8 will survive any termination of this License.
b. Subject to the above terms and conditions, the license granted here is perpetual (for the duration of the applicable copyright in the Work). Notwithstanding the above, Licensor reserves the right to release the Work under different license terms or to stop distributing the Work at any time; provided, however that any such election will not serve to withdraw this License (or any other license that has been, or is required to be, granted under the terms of this License), and this License will continue in full force and effect unless terminated as stated above.

8. Miscellaneous

a. Each time You Distribute or Publicly Perform the Work or a Collection, the Licensor offers to the recipient a license to the Work on the same terms and conditions as the license granted to You under this License.
b. Each time You Distribute or Publicly Perform an Adaptation, Licensor offers to the recipient a license to the original Work on the same terms and conditions as the license granted to You under this License.
c. If any provision of this License is invalid or unenforceable under applicable law, it shall not affect the validity or enforceability of the remainder of the terms of this License, and without further action by the parties to this agreement, such provision shall be reformed to the minimum extent necessary to make such provision valid and

enforceable.

d. No term or provision of this License shall be deemed waived and no breach consented to unless such waiver or consent shall be in writing and signed by the party to be charged with such waiver or consent.
e. This License constitutes the entire agreement between the parties with respect to the Work licensed here. There are no understandings, agreements or representations with respect to the Work not specified here. Licensor shall not be bound by any additional provisions that may appear in any communication from You. This License may not be modified without the mutual written agreement of the Licensor and You.
f. The rights granted under, and the subject matter referenced, in this License were drafted utilizing the terminology of the Berne Convention for the Protection of Literary and Artistic Works (as amended on September 28, 1979), the Rome Convention of 1961, the WIPO Copyright Treaty of 1996, the WIPO Performances and Phonograms Treaty of 1996 and the Universal Copyright Convention (as revised on July 24, 1971). These rights and subject matter take effect in the relevant jurisdiction in which the License terms are sought to be enforced according to the corresponding provisions of the implementation of those treaty provisions in the applicable national law. If the standard suite of rights granted under applicable copyright law includes additional rights not granted under this License, such additional rights are deemed to be included in the License; this License is not intended to restrict the license of any rights under applicable law.

Creative Commons Notice Creative Commons is not a party to this License, and makes no warranty whatsoever in connection with the Work. Creative Commons will not be liable to You or any party on any legal theory for any damages whatsoever, including without limitation any general, special, incidental or consequential damages arising in connection to this license. Notwithstanding the foregoing two (2) sentences, if Creative Commons has expressly identified itself as the Licensor hereunder, it shall have all rights and obligations of Licensor. Except for the limited purpose of indicating to the public that the Work is licensed under the CCPL, Creative Commons does not authorize the use by either party of the trademark "Creative Commons" or any related trademark or logo of Creative Commons without

View all

Back to main

Social Cognition

Glasser's choice Theory

Cognitive Map

Psychological effects of Internet Use

Theoretical Linguistics

Prototype Theory

Binding Problem

Spatial Ability

Modularity of Mind

Dual-coding Theory

Sense of Agency

Mental Process

Einstellung Effect

Intentional Stance

Machiavellian Intelligence

Quantum Cognition

Noogenesis

Spatial Relation

Construction Grammar

Expectation confirmation Theory

Learning Sciences

Cognitive Inhibition

Spatial–temporal Reasoning

Eye movement in Reading

Social Neuroscience

Grandmother Cell

Cognitive Semantics

Number Form

Body Schema

Sensory Cue

Number Sense

Multiple Realizability

Interaction Theory

Congruence Bias

Biolinguistics

Learning

Prosodic Unit

Crosslinguistic Influence

Spatial contextual Awareness

Cognitive Biology

Laws of Association

Approximate number System

Malleability of Intelligence

Common coding Theory

Decision field Theory

Protocol Analysis

Cognitive Archaeology

Augmented Learning

Bongard Problem

Cognitive Poetics

Embodied embedded Cognition

Cognitive Geography

Computational Semiotics

Semantic feature-comparison Model

Artificial intelligence, situated Approach

Planning (cognitive)

Primary Consciousness

Theory of Mediation

Bayesian cognitive Science

Simplicity Theory

Rational Analysis

Cognitive Sociology

Visual Modularity

Cognitive approaches to Grammar

Cognitive Rhetoric

Scientific Consensus

Cue Validity

Mental World

Associative group Analysis

Physical symbol System

Macrocognition

Frame-based Terminology

Category Utility

Epidemiology of Representations

Cognitive Philology

Subgoal Labeling

Embodied bilingual Language

Anthony Leiserowitz

Cognitive hearing Science

Fictive Motion

Neuroscience

Umoove

Cognitive Theory of Inquiry Teaching

Back on top

A (Back to main TOC)

Next (B)

Computational Semiotics

Congruence Bias

Construction Grammar

Crosslinguistic Influence

Cue Validity

Cognitive Philology

Cognitive Poetics

Cognitive Rhetoric

Cognitive Semantics

Cognitive Sociology

Cognitive Theory of Inquiry Teaching

Cognitive approaches to Grammar

Cognitive hearing Science

Common coding Theory

Computational Linguistics

Computational Semiotics

Congruence Bias

Construction Grammar

Crosslinguistic Influence

Cue Validity

Decision field Theory

Dual-coding Theory

Einstellung Effect

Embodied Cognition

Embodied bilingual Language

Embodied embedded Cognition

Epidemiology of Representations

Executive Dysfunction

Expectation confirmation Theory

Eye Tracking

Eye movement in Reading

Fictive Motion

Frame-based Terminology

Functionalism (philosophy of mind)

Generative adversarial Network

Glasser's choice Theory

Grandmother Cell

Informatics

Intentional Stance

Interaction Theory

Laws of Association

Learning

Learning Curve

Learning Sciences

Linguistics

Machiavellian Intelligence

Macrocognition

Malleability of Intelligence

Mental Model

Mental Process

Mental World

Metacognition

Modularity of Mind

Multiple Realizability

Neuroscience

Noogenesis

Number Form

Number Sense

Perception

Physical symbol System

Planning (cognitive)

Primary Consciousness

Prosodic Unit

Protocol Analysis

Prototype Theory

Psychological effects of Internet Use

Quantum Cognition

Rational Analysis

Schema (psychology)

Scientific Consensus

Semantic feature-comparison Model

Sense of Agency

Sensory Cue

Simplicity Theory

Social Cognition

Social Neuroscience

Spatial Ability

Spatial Relation

Spatial contextual Awareness

Spatial–temporal Reasoning

Subgoal Labeling

Theoretical Linguistics

Theory of Mediation

Theory of Mind

Umoove

Visual Modularity